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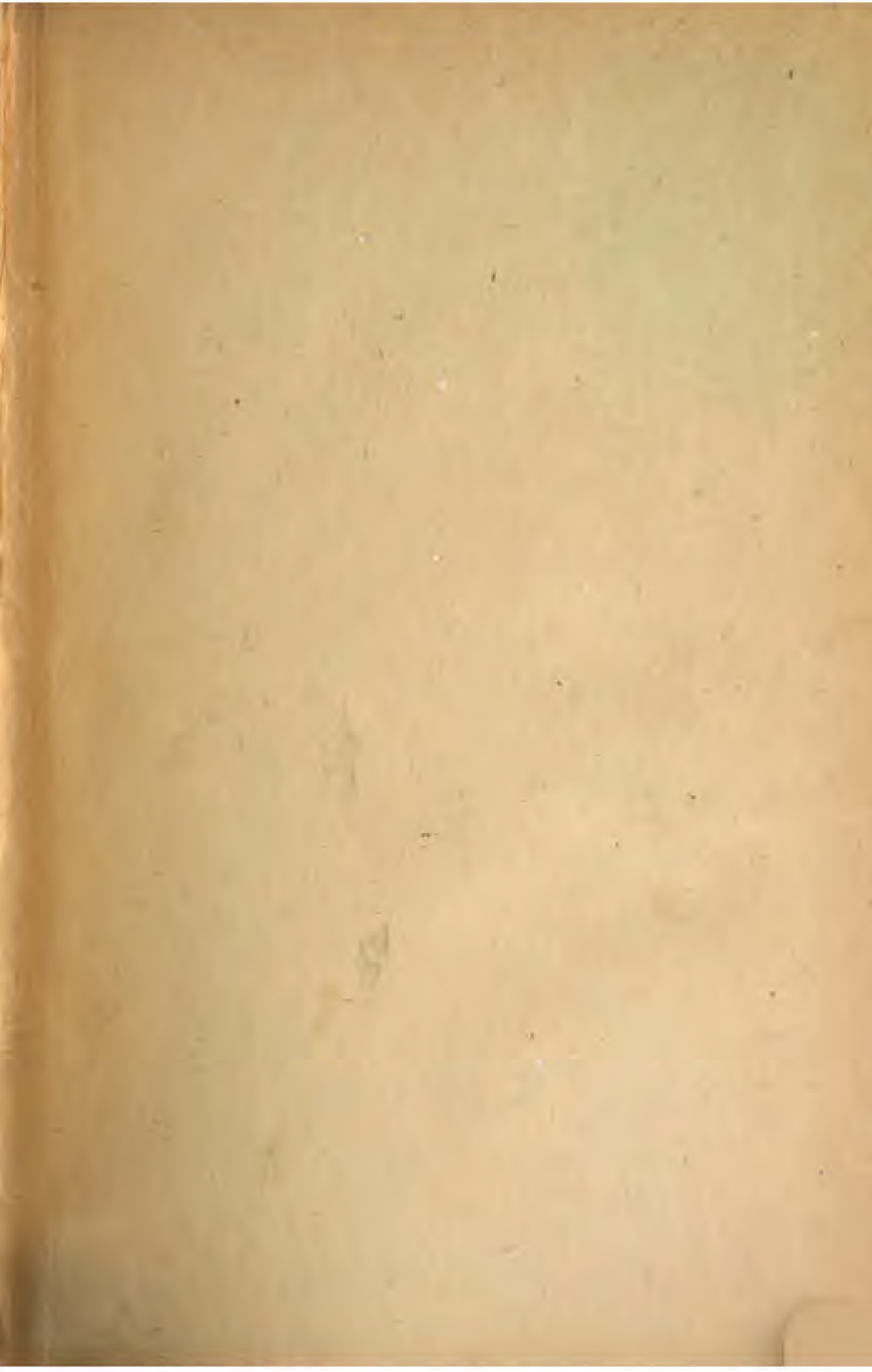
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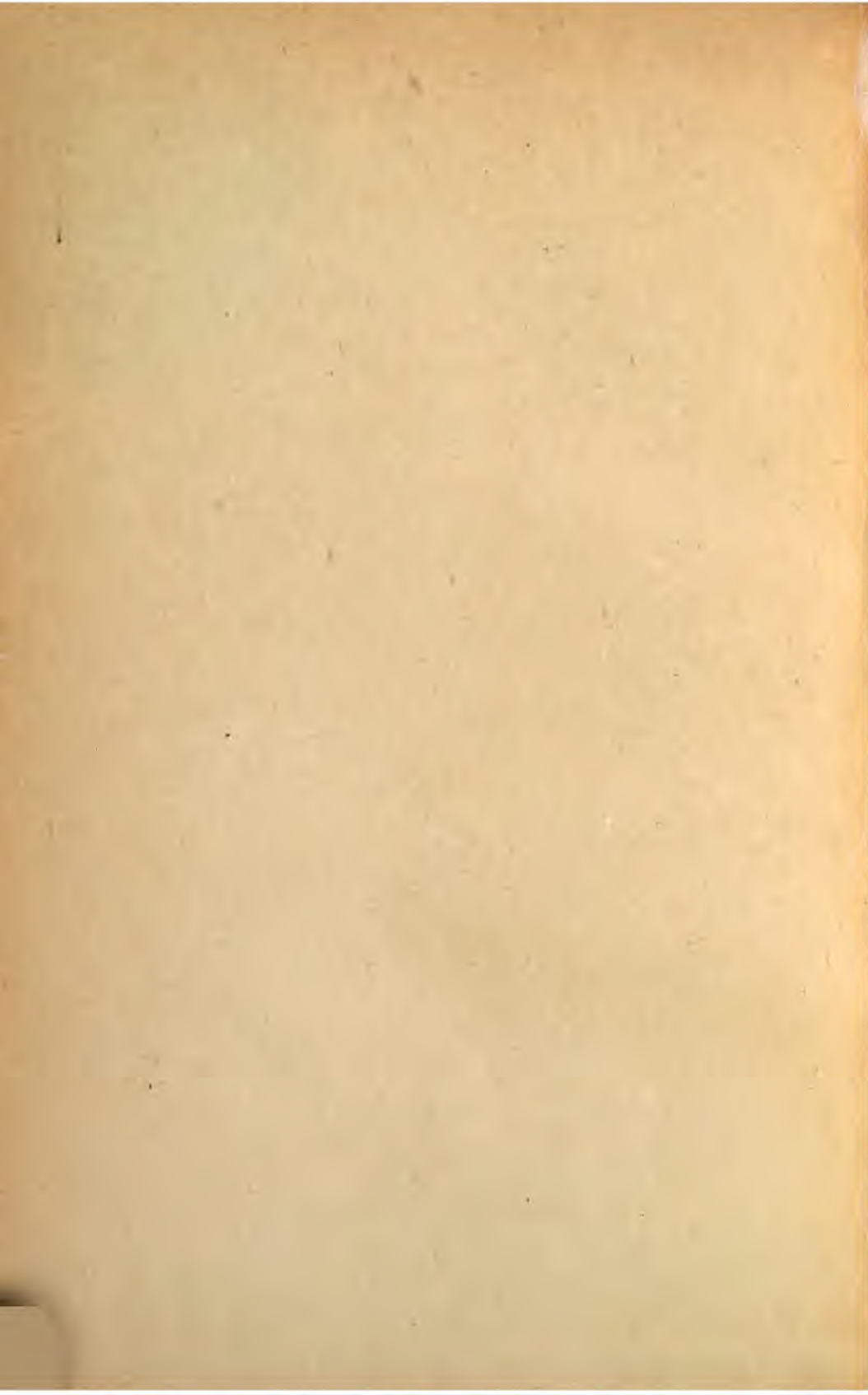


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ZOOLOGICAL BULLETIN

OF THE



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OF THE

PENNSYLVANIA DEPARTMENT OF AGRICULTURE

VOL. II.—No. 1

SUBJECT: { Horticulture,
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Nursery Inspection Report.

JANUARY 1912.

H. A. SURFACE, D. Sci., Economic Zoologist,
Editor

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VOL. II, No. 1.

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BULLETIN.**

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HORTICULTURAL OPERATIONS DURING THE DORMANT SEASON.

In certain numbers of the Zoological Bulletin of the Division of Zoology will be found detailed directions for treating trees, farm and garden crops, etc., for the destruction of insect pests and the prevention of fungous diseases to which they are subject. Vol. 1, No. 1, of the Bi-monthly Bulletin, for Jan., 1911, contains such information. Since reference can be made to these for this information, and we have a number of extra copies of such bulletins for free distribution, it is not intended to repeat in this issue much of the advice and instruction already given in earlier numbers of this Bulletin, but the plan is rather to direct the attention of farmers and horticulturists to such work as may be done at this season of the year. We particularly indicate those operations which are best performed during the dormant season, some of which, indeed, can not be done safely and with best effect at any other time.

In this State most orchard owners are also engaged in diversified farming, or at least have to attend crops, other than fruits, each requiring part of their time and special attention at stated seasons. Even the fruit growing specialist has his busy seasons when orchards must be cultivated, codling moth spraying done, and the fruit crops harvested and sold. At such times no other work can be undertaken, nor plans made for anything except the work in hand.

During the winter there is a lull in the special activities of the fruit grower, during which time much can be done in the orchard, and the present article is written in the hope that the orchardists may be induced thereby to follow the practices recommended, to the end that pests may be controlled and a finer grade of fruit grown within the boundaries of this Commonwealth. We shall outline much of the work, so that orchard owners may make adequate preparations for the same, placing their orders for spraying machinery, insecticides, and other supplies accordingly, as required.

GENERAL ORCHARD MANAGEMENT.

The Destruction of Weeds. As a rule few weeds are found growing well kept orchards, and the practice of clean culture, with a winter cover crop, adopted by an ever increasing number of orchardists throughout the State, is to be commended, both for the advantage

gained by retaining soil moisture, and promoting the growth of the trees, as well as to increase the quantity and value of the fruit. This practice, or that of interchopping with such cultivated crops as corn, potatoes, beans, peas and other hoed or cultivated crops grown in the orchard, usually suffices to hold in check any luxuriant growth of weeds in the ordinary season. However, even with the most zealous persons some weeds will spring up, at least during a wet season. Often these are confined to the area immediately about the trees and in the tree row between the trees, not so easily reached by the cultivator.

Growing weeds rob the soil of plant food and moisture, thus increasing the effects of drought at a time when the tree stands in the greatest need of water. Their presence, therefore, although extenuated by some, on the ground of supplying mulch for the soil, bodes no good, and the orchardist can well afford to make an earnest effort to destroy them at this season or at any time before the ground is covered with snow.

All weeds should, therefore, be mowed, before their seeds are formed if possible, gathered on piles and burned, or better, thrown into a compost heap to rot and become humus. Thus the weed seeds will be destroyed, and pollution of the soil with these will be prevented, and the battle against these pests during next season will be already partly won. Many insects pupate or hibernate in weeds, and they are also killed by burning, burying, or rotting the host plants. Weeds in the orchard offer attractive advantages to the adults of borers which lay their eggs during the summer, and it becomes much more difficult to control these troublesome and destructive pests where weeds are allowed to flourish. Besides, the presence of rubbish, trash, etc., of any kind, in the orchard, attracts mice, and, consequently increases the danger of girdling trees by these animals during the winter when snow covers the ground.

Burning Rubbish. To those who study the life histories of insects the presence of any kind of waste materials, such as fragments of limbs, old bark, parts of weeds, the prunings of trees, or rotten and mummied fruits on the trees or in the orchard, is recognized as a menace to the trees and fruit, in that, during the winter season they harbor insects and germs of diseases, thus carrying them safely over into the summer season, when they emerge and reinfest the trees and crops. Thus the Codling moth is now resting beneath fragments of bark on the trunk and under the trees near the point where the wormy apples, from which the larvae crawled, dropped last fall. Seed Chalcids are wintering inside the weeds within the infested apples still remaining on the trees or lying under them on the ground. Mummied fruits of the peach, plum and apple on the trees harbor the

spores of the Monilia or Brown Rot and Bitter Rot, and all should be removed and burned or buried, in accordance with the directions under the respective heads treating these pests, prior to giving the orchard a general treatment of disinfection.

The Lime-Sulfur Spray. We are now so thoroughly convinced of the great general value of an annual spraying of all fruit trees, but especially peach and plum, with the lime-sulfur solution at the strength indicated by the hydrometer test of 1.03 sp. gr., during the dormant season, that it is here recommended to be applied as a universal practice in all orchards within the State, once each year without regard to the presence or absence of any particular pest or pests. This treatment comes nearer being an orchard panacea than any other known treatment now available.

Lime-sulfur is not only the sovereign remedy against San José scale, Oyster-shell scale, Scurfy scale and resting winter spores of most fungous diseases, as Leaf Curl and Monilia Rot, but also a sure destroyer of the eggs and young of many destructive insects and other pests now on the trees as, for example Leaf blister mite; Red Spider, Apple aphids, Wooly aphids, Bud moth worm, Gall-mite, etc. Indeed, the rapid improvement in the condition of fruit trees of all classes from a state of unthriftiness and injury, under the most trying conditions, after receiving thorough treatment with the lime-sulfur solution, can only be accounted for on the basis of some direct stimulant or tonic effect by lime-sulfur, possibly by absorption of this material into the tissues of the trees.

The spray falling upon the ground acts as a valuable fertilizer and is in no way detrimental to the health of the most delicate tree or shrub. I have seen trees in the orchard of one of the most prominent and successful fruit growers in the State, which have for the last six years been treated to a heavy dressing of the residue of the boiling of lime-sulfur, made after the 17-22-50 formula, spread thickly upon the ground as far as the limbs extend, with not the least evil effect, but considerable evident improvement in the vigor and fruitfulness of these trees above their neighbors. We hope some Experiment Station may take up the subject of the fertilizing effect of lime-sulfur upon plants, and thus give a working knowledge to guide growers. Meanwhile we can make no mistake in practicing most thorough treatment of all fruit trees annually during the dormant season, with lime-sulfur solution.

In answer to requests for an estimate on the quantities of materials necessary to spray a given number of trees, I submit the following table, which has been compiled on the basis of actual experience in the orchard, and while the amounts are liberal they will serve very well in calculating the requirements for the various spraying operations.

Lime-Sulfur Spray.

For each 1 yr. apple, pear or quince tree,	1 pt.
For each 5 yr. apple, pear or quince tree,	$\frac{1}{2}$ gal.
For each 10 yr. apple, pear or quince tree,	$2\frac{1}{2}$ gal.
For each 15 yr. apple or pear tree,	5 gal.
For each 20 yr. apple or pear tree,	$7\frac{1}{2}$ gal.
For each 30 yr. apple or pear tree,	10 gal.
For each 1 yr. peach, plum or cherry tree,	1 pt.
For each 3 yr. peach, plum or cherry tree,	$\frac{1}{2}$ gal.
For each 5 yr. peach, plum or cherry tree,	1 gal.
For each 8 yr. peach, plum or cherry tree,	2 gal.
For each 10 yr. peach, plum or cherry tree,	3 gal.
For each currant or rose bush,	1 pt.

PRUNING.

The present season, when trees are leafless, offers distinct advantages for pruning. Whatever work in this respect is necessary should be done before that of spraying is undertaken. By so doing the work of spraying is facilitated and thoroughness is made possible and easy. Besides, it is useless work and expense to cover with spray materials the limbs which are to be cut out in pruning. The fruit buds are also now well protected and less liable to injury by the removal of limbs than at any other time. In addition, one can prune while the weather is not favorable to perform any other orchard operation. We emphasize the point that pruning and spraying can be done at any time when the trees are leafless.

In undertaking the pruning of any tree in the orchard, one should have clearly in mind the definite purpose for which the pruning is to be done and the object to be attained. When there is not a good reason for removing a limb, this is a very good reason for letting it remain. One can remove a limb in a few minutes, but it will take years to replace it. More fruit trees have, in the past, been ruined and more fruit destroyed by the injudicious pruner than by any other single pest. Fortunately, the man who goes about in the orchard with his ax, cutting and slashing at random, specializing in the removal of lower limbs, has passed away, let us hope, forever. We still have with us the "trimmer," who insists on "pruning up," that is, cutting off the lower limbs, and trimming the tree on what is called the "cow tail" method; in other words, taking away all the lower lateral or side limbs, so that the remaining clump of branches at the top resembles, not a little, a cow's caudal appendage.

There is still much cutting of larger limbs without protecting the wound thus made with a coat of paint,—a practice which is almost sure to result in rotting the heart of the tree, thus causing a wound

which is difficult to repair. All wounds made in trees of more than one inch in diameter should be painted over with white lead and raw linseed oil paint or melted pitch, and thus kept covered until they are naturally protected by the growing bark healing over. There are everywhere signs of a more intelligent study of the principles of pruning underlying the art, with the result that the number of orchards containing well shaped trees is rapidly increasing in this State, especially in our Demonstration Orchards.

We sum up here the principal purposes for which pruning of trees is done:

OBJECTS OF PRUNING.

1. *To remove dead, broken, diseased and dying branches.* Dead limbs of a tree are not only unsightly, and occupy space needed for the growing limbs but serve to harbor insect pests and diseases, and should be removed without delay. Limbs broken from any cause whatever should either be cut back close to the origin of such branches as are to remain, or be removed entirely. Ragged wounds made by breaking limbs will not heal over, so that if parts of broken limbs are to remain such stubs must be cut off and the wound thus made painted over. Limbs or branches affected with canker, blight, or with borers, or weakened by any other disease or insect, should be removed and burned.

2. *To give shape to the tree.* Young trees in charge of the pruner are as clay in the hands of the potter, to be shapen and moulded as he desires. The most important pruning a tree can ever receive is, without doubt, that given shortly after planting, and again after its first year's growth, for the purpose of forming a head by cutting it back to a certain height and shape. Later each branch which is to form the framework of the tree should be cut back to the bud located on the side of the branch from which is to grow a future main limb. In this way trees can be given any shape desired, although the favorite method of pruning fruit trees is to form what is known as the open-headed or urn-shaped top. Fruit grown on an open headed tree will be sure to receive the advantages of the rays of sunlight reaching them, and thus be of higher quality and color, less subject to fungous attacks, more easily and more perfectly sprayed,—hence less defective,—and easier reached for thinning and picking.

3. *To remove limbs crossing or interfering and competing with each other for the same space.* Crossing limbs rub against each other by action of the winds, and are thus injured and weakened, and for this reason alone one should be cut out. Such limbs, together with parallel limbs, or two limbs growing where there is room for but one, are competing for the same space on a tree, and one must be removed.

The rule to follow is to cut the weaker limb or that limb which will make room for the largest number of neighboring limbs by its removal, or (better) that which is less needed for the symmetrical development of the desired top. This will give freedom and vigor to the remaining limbs, and will also result in healthier foliage and fruit, and larger, better colored fruits. It is impossible to produce sound fruit of good quality and fair size on a tree overcrowded with twigs and branches and shutting out the sunlight. By cutting out the unnecessary and crowding branches, one does at the same time remove the superfluous buds which reduce the number of fruits formed, and this is sure to result in increased size and quality of fruits grown from the remaining buds.

4. *To head back long shoots or branches.* On rapidly growing trees, especially young trees, some branches will be noticed to be making vigorous growth and shooting above the remainder of the limbs. If such branches are allowed to continue in the lead the result will be an unsymmetrical top. Such limbs should be cut back to at least the length of the remainder of the branches on the same tree, and forced to develop side branches in order to fill up any gap, and spread the tree in a lateral direction. By cutting back upward growing branches each to a side branch, the pruner is able to keep the head of the tree low. The great objection to the old style trees is that they are entirely too tall for modern methods. The fruit grower of the future who will meet with the best success will be the man who prunes in such a manner as to make low spreading tops. This will make it possible for him to spray his trees, and thin and pick his fruit in a manner that will be convenient, and do away with the loss of time, personal danger, and damage to fruit due to climbing tall trees with high ladders.

5. *To repair injury to the tree.* When a tree is badly injured by any cause, especially by San José scale, the first step in its treatment should be to prune it thoroughly. The fundamental principle in all pruning is to cut back every damaged tree in proportion to its injury. A tree which has suffered from the attacks of San José scale is often more seriously injured than would at first appear. The poison injected into the living bark of the tree by this insect causes a discoloration under the bark, which can be seen readily by removing the outer coat of the bark. That part of the tree showing red and brown discolorations of the bark should be removed. Trees that have been injured at the trunk by blight, borers, mice, rabbits, implements, etc., should be pruned back, for the reason that a certain portion of the bark on the trunk has been destroyed, and the supply of sap from the roots has been curtailed or checked to this extent.

6. *To increase the vigor of the tree.* Nearly all trees have a larger number of buds than can be developed into strong branches and fine fruit. If a tree is suffering from any cause whatever, the drain upon its vitality in its effort to mature all its buds will be a heavy burden upon the tree. If three-fourths of the branches and buds be cut away the life that would have gone into the entire number of buds will be concentrated in those remaining, and thus the tree becomes much improved in vigor. The result of this pruning will be the growth of a few shoots or branches of large size, instead of many of a small growth, and thus the tree will be able to carry itself over a period of adversity, and its life and vigor may be renewed. Old peach trees with good roots and trunk, for example, when severely cut back or "dehorned" will be given a new lease of life, and form new tops on the old trunks, setting fruit buds for the next year's bearing, while if they had not been thus pruned they would have declined gradually and died. The old well known statement that "pruning is fertilizing" has, therefore, its foundation in the fact of stimulation, especially when done when the trees are dormant, for this does, without doubt, increase the vegetative functions of the tree by stimulating growth. An accurate statement therefore is, "Dormant pruning is stimulation."

7. *Effects of pruning on bud formation.* A well known adage is that "we prune in the winter for wood, and in the summer for fruit." There is no doubt that pruning at different seasons of the year has entirely different effects upon the tree. If, therefore, a tree of bearing age is making too much wood growth it would be wrong horticultural practice to prune such tree in the dormant season, since this would only increase the present trouble and defer the period of bearing. If small branches of bearing fruit trees, are therefore, cut back in midsummer such pruning will tend to develop fruit buds for next season's crop. If the ends of the twigs of stone fruits be cut back in August this pruning will develop into fruit buds many that otherwise would have been leaf buds. It is thus possible on vigorous young peach trees to prune them in such a manner as to cause them to bear fruit on one side of the tree and leaves on the other, thus showing that the effect is entirely due to pruning.

Date of pruning. The question is often asked, "Will a wound made in pruning in the fall of the year heal over as readily as one made by spring pruning?" To this I would reply that there is little difference, especially if the wound made in the fall of the year is soon covered with paint or other proper material to protect it from evaporation of moisture and cracking open, although the cut bark in the spring will immediately begin to grow, and proceed to cover the wound without

danger of cracking. In cutting off limbs larger than one inch in diameter in any season it is always advisable to paint the wounds with water-proof material, such as paint made of white lead and raw linseed oil, or cover them with grafting wax, melted pitch or sealing wax. This will keep out the germs of decay and insure speedy healing over of the wound. If there be much wood to be removed from the tree it is always better, other things equal, to cut this out during the dormant season, because there will be then less danger from breaking off and destroying the fruit buds than at any other time. However, it is better to prune a little once each year than to give the trees a thorough overhauling only once every three or four years.

Cost of Pruning. The expense of pruning an orchard varies necessarily with the size of the trees, previous pruning received, and the present condition and needs. If the orchard is gone over once a year taking out such branches as are required, the work of pruning is not expensive nor burdensome to the owner, and it is then seldom if ever necessary to remove large limbs from the trees. We do not, however, find ideal conditions in very many orchards, and must make our estimates accordingly.

In the pruning of trees two or three years old, where one can make all cuts with the pruning shears or pruning knife, the experienced pruner would require but a few minutes to complete the work on each; whereas apple trees of large size, ranging in age from twenty to forty years and more, that have not been pruned for many years, may require the time of an industrious workman from one-fourth to one-half day each. Even this amount of time would be justified by the improved condition of the tree, and the increased returns from a few crops of fruit.

The chief difficulty experienced by persons not able themselves to give their trees necessary attention, is in getting competent men to do the work. Until this can be done, or one is prepared to undertake the pruning himself, it would be well to go slowly in delegating this important work to any person not properly qualified to do the same.

The Disposal of Brush. When limbs are cut from diseased or infested trees, such as those suffering with pear blight or plum knot, it is important that the brush be gathered and burned at once. This should also be done when limbs are infested with bark borers. Limbs infested with San José scale cut off during the dormant season need not be burned immediately, as this pest will never be able to free itself and pass to other trees, and will die before its young appear. It is, however, good orchard practice to burn all prunings, and these especially should not be left to lie about the orchard for several seasons, since they are sure to harbor insects and germs of disease.

TREATMENT FOR ORCHARD PESTS.

San José Scale. Treatment may be applied for the San José scale at any time during the dormant season up to the time the buds are unfolding in March and April. In fact, in cases of emergency, spraying with full strength lime-sulfur solution may be done up to the time of blossoming. I do not recommend this treatment for trees while in blossom, as a general practice, since the caustic effect of the spray solution when this reaches the fruiting organs of the flowers may destroy them, but we have often safely sprayed with strong lime-sulfur when the pink color of the bursting blossoms could be seen. Extensive fruit growers find it expedient to begin the winter spraying with lime-sulfur solution in the fall of the year, as soon as the leaves have dropped from the trees, taking advantage of favorable weather during the winter season, since it is often impossible, because of adverse winds and other unfavorable weather conditions, to complete the spraying of a large orchard in the spring, and this practice of fall and winter pruning and spraying is to be highly recommended. It is, however, apparent that, on the whole, better results are obtained in the control of certain pests by making the application of this spray shortly before the buds open.

The most important points in spraying for San José scale are thoroughness and applying the liquid at proper strength. The former can be assured by the use of a good spraying outfit, kept in proper condition, and the latter by observing the following conditions for treatment:

Seriously infested trees should be carefully pruned, cutting them back in proportion to their injury, as indicated by dead and dying limbs and the red color in the twigs. Spray all infested trees, covering them entirely from top to bottom, with lime-sulfur solution, using one of the following:

Lime-sulfur solution (Old Home-boiled, Dilute). This is made by slaking 22 pounds of quick lime (fresh stone lime) to which is added 17 pounds of finely powdered or ground sulfur previously mixed into a paste with a little water to break up any lumps which may be present. Boil in an iron kettle in sufficient water for an hour, and dilute to make 50 gallons. Strain this well through a fine brass wire netting, having about 30 wires to the inch. Spray at once, or before the mixture gets cold.

(Better) Lime-sulfur solution (Home-boiled, Concentrated). Slake 60 pounds of high grade lime, adding 125 pounds of fine sulfur as described above, and boil in 50 gallons of water for one hour. If necessary add water to make up for evaporation; strain and store in closed vessels until needed, or in open vessels, keeping the solution covered with a thin film of oil. When ready to spray, dilute one part with 6 or 7 parts of water, or to specific gravity, as shown b

Hydrometer test, of 1.04 to 1.03. This is practically the same as the simplified formula of 1 pound of fresh lime and 2 pounds of powdered sulfur for each gallon of water. Boil 1 hour; then settle or strain, and store until needed.

Lime-sulfur solution (Commercial Concentrated). Many manufacturers are placing upon the market ready-made concentrated lime-sulfur solutions, and these are found satisfactory and as effective as the home-boiled solution, when used at the same strength. They should be diluted, as a rule, by adding to one part of the concentrated mixture about 7 or 8 of water, or to specific gravity, as shown by Hydrometer test, of 1.04 to 1.03.

The Oyster-Shell Scale. This species of scale insect differs from the San José scale in several respects, but principally in the fact that it lays eggs and dies shortly after laying, while the San José scale continuously bears living young throughout a period of several months during the summer and fall. From these eggs hatch small, delicate, free-moving insects about the middle to the last week in May, and in the warmer parts of the State there is a second brood hatching in August. The usual treatment recommended to destroy this scale is to spray the infested trees with a dilute contact insecticide, such as lime-sulfur solution diluted to 1.01 sp. gr. or 10 per cent, kerosene emulsion, or fish oil soap solution, one pound to six gallons of water at the time the young are hatched. However, the treatment with the lime-sulfur solution recommended for San José scale during the dormant season is also effective in destroying the Oyster-shell scale at this time (now in their egg state) when applied upon infested trees. It is obvious, therefore, that where any trees or shrubs are infested with both San José scale and Oyster-shell scale, as is the case in so many orchards in the State, one thorough treatment with lime-sulfur solution will destroy both pests.

Scurfy Scale. This scale insect, like Oyster-shell scale, passes the winter in the egg state beneath the tough, white, waxy covering, and any treatment applied during the dormant season would have to be sufficiently strong to destroy these purple red eggs under the scale, just the same as for the Oyster-shell scale. As a rule, the lime-sulfur solution applied at the strength recommended for San José scale is effective in destroying the eggs, and is here recommended.

The Scurfy scale is found rather generally distributed in the apple orchards of this State, and currant bushes are especially liable to be injured and killed by it. The young of this species of scale hatch about the same time as the Oyster-shell scale, viz., about the last week in May, and are purple red in color. They can be destroyed readily by spraying the infested trees at that season with a dilute contact insecticide as recommended for Oyster-shell scale, or with extra dilute lime-sulfur solution testing 1.01 sp. gr. on the hydrometer.

Lecanium Scale, or Soft Scale. These are our largest scale insects, and two species usually infest peach and plum trees. They are brown in color, and in size and shape resemble half of a split pea. Because of this characteristic shape it is often called Turtle-shell and Terrapin scale. The young appear as brownish, free-moving insects in July. To destroy the *Lecanium* scale, spray during the dormant season with a 20 per cent. kerosene emulsion, made by using one part of the stock solution and three parts of hot water. The stock solution is made by dissolving one pound of soap (common soap, or better fish oil soap), and add to this two gallons of kerosene, stirring and whipping it into a thick creamy mass. This can be kept indefinitely for use in making the dilute emulsion at any strength desired. Summer treatment consists of spraying the infested trees, when the young insects are found crawling upon the limbs, with an 8 per cent. kerosene emulsion, made by dissolving one gallon of stock solution in 8 gallons of water, or spraying with fish oil soap, one pound to six gallons of water, or (best) with extra dilute lime-sulfur solution; or with Scott's formula self-boiled lime-sulfur.

Bud Moth. This insect enters the buds of the pome fruits in early spring, just when they begin to open, cutting off the terminal growth and thus destroying the blossom buds. Later the caterpillar ties the very young leaves together, forming a conspicuous nest. It passes the winter encased in a tube made from the rolled-up half of a leaf. From this it emerges about half grown in the early spring, and eats its way into the bud. If trees known to be infested with the bud moth are sprayed with lime-sulfur solution at the time immediately preceding the opening of the buds the pest will not appear in any large numbers, since this treatment will destroy it. The summer treatment consists in spraying with an arsenical at the time the first leaves appear in the buds, and repeat again in about a week or ten days, or just before the blossoms open.

Case Bearers. These insects attack the buds as soon as they begin to open, and often burrow into them eating their contents. Later the caterpillars eat into the young fruits and leaves, leaving only the skeleton of the latter. They do not leave their cases while feeding, but protrude enough of their bodies to enable them to mine out irregular areas of the leaves. Treat the same as recommended for bud moth.

Leaf Crumpler. This is another insect which awakens into activity about the time of the swelling of the buds, and winds a web around the new leaves of the bud which are drawn together, crumpling the leaves and forming a case with its silken threads. Inside of this case it feeds in comparatively safety. The same treatment is recommended as for the bud moth and case bearers.

Apple Aphis. The eggs of the aphids or plant lice are deposited by special egg-laying individuals upon small twigs of the trees late in the fall, in which stage the winter is passed. From these eggs early in the spring individuals hatch, which become the mothers of numerous offspring, and they are very destructive to plant life. It has been found that trees sprayed with lime-sulfur solution, the same as recommended for San José scale, are not generally injured by the apple aphis, and this is now known to be due to the fact that the eggs upon the trees during the winter and early spring are destroyed by the lime-sulfur solution, especially when applied just about the time of the bursting of the buds.

Effective work in controlling these insects may be done after the leaves appear on the tree by spraying with kerosene emulsion or fish oil soap, as recommended for the young of the Oyster-shell and Scurfy scale, or tobacco decoction made by steeping one-half pound of tobacco leaves, stems or dust in one gallon of water, slowly raised to the boiling point and then allowed to cool. Care must be taken to wet thoroughly all parts of the infested plants. Should any leaves be curled, so as to prevent the spray from reaching the insects, these must be pulled off and destroyed. The thorough spraying with strong lime-sulfur when the leaf buds are bursting is best and cheapest.

Leaf Blister-Mites. The Blister-mites are small white, or pinkish white mites which produce open galls or blisters, looking like blotches of soot on the under surface of leaves, and on fruits and fruit stems of apple and pear. They spend the winter under the scales of the buds. As soon as the leaves unfold in the spring they leave their winter quarters and enter the stomata, first on the young leaves near the base of the growing bud, spreading to those toward the end of the twig as the season advances. The eggs are deposited in the tissue of the leaves some time in April and early May. The young mites hatching from these eggs burrow through the epidermis of the under side of the leaf, and feed upon the tissues in the interior. This irritation produces a sooty thickening of the leaf, which is known as the "gall" or "blister." Other eggs are deposited throughout the season, within the galls, and the young mites after hatching, tunnel in all directions, thus enlarging the galls. Through an opening in the under surface the mature mites emerge and pass to other localities, where they form new galls. There are numerous generations throughout the season, as they breed for a period of about six months. In October the adult mites seek shelter for the winter in the buds.

The injury from these pests first manifests itself by small green, red, or yellow patches or pimples which enlarge, run together, and form irregular dead areas, turning brown and dark later in the season. Severely infested leaves lose their fresh green color, acquire

a variegated appearance, and drop from the tree. The affected fruits are either destroyed, or, if they recover from the early attacks, become stunted and blotched, and develop into fruit of poor quality.

The Leaf Blister-mite is already generally distributed over a large part of this State, and has been found by the inspectors of the Division of Zoology in the following counties:

Allegheny,	Clearfield,	McKean,
Armstrong,	Columbia,	Mifflin,
Bedford,	Cumberland,	Northumberland,
Berks,	Erie,	Potter,
Bradford,	Fayette,	Schuylkill,
Bucks,	Greene,	Somerset,
Cambria,	Lackawanna,	Susquehanna,
Cameron,	Lawrence,	Tioga,
Centre,	Luzerne,	Washington,
Chester,	Lycoming,	Wayne.

The annual loss by this pest can be safely estimated at not less than \$200,000 in Pennsylvania alone.

Treat by spraying infested trees in the fall as soon as the leaves have dropped from them, and again in the spring or latter part of winter, thoroughly, with the lime-sulfur solution as for San José scale, or spray with kerosene emulsion diluted one part of the regular stock solution with five times its bulk of water. The dormant spraying for scale is in every detail the one which has been entirely satisfactory in clearing up Leaf Blister-mite.

Curculios. These insects injure young fruits of several classes, in which the eggs are deposited early in the growing season. They are commonly seen in the larval stage in "wormy" peaches, plums and cherries. The standard treatment for these is to spray with arsenate of lead mixed in water, Bordeaux mixture, or extra dilute lime-sulfur, at the rate of two pounds of the poison in fifty gallons, as soon as the buds burst and the young leaves are formed. Repeat this treatment immediately after the petals fall, and again three weeks thereafter, and again a month later. However, since these insects hibernate beneath the surface of the ground, turning the soil by plowing and very late fall and early spring cultivation will aid in destroying them by breaking the earthen cells in which they pass the winter.

The Apple Seed Chalcis. This is a small green-colored gnat like insect, in its mature state about one-eighth of an inch in length. The eggs are deposited in the seeds of apples when the fruit is one-half inch or more in diameter. On warm sunny days in June the female alights upon the young apples, and drives her long ovipositor

through the flesh and into the seeds. The eggs are pure white, and hard to see in the young seeds. From the eggs hatch grub-like larvæ, having brownish heads. They feed on the soft contents of the kernels until September, at which time they become full grown larvæ, having devoured the entire kernel of the seed. They pass the winter inside the seed shells in the pupal state, emerging from the apple as mature insects early in the following summer.

The damage done to fruits by the Chalcis consists principally in dwarfing and gnarling the apples in a characteristic manner. It is estimated as being at least \$100,000 annually in Pennsylvania, and has been found present in orchards in the following counties:

Berks	Luzerne	Somerset
Bradford	Lycoming	Susquehanna
Bucks	Northampton	Tioga
Chester	Northumberland	Wayne
Greene	Potter	Wyoming
Lackawanna	Schuylkill	

Infested apples are not only undersized, but misshapen, and lacking in symmetry. The point at which the egg was introduced appears as a black dot occupying a depression on the surface of the fruit. From this puncture a brownish line of hardened tissue extends to the infested seed.

Since the insects remain in the seeds throughout the winter, it is necessary to destroy the apples left under the tree in the fall, as well as such as remain upon the tree. The complete destruction of all such apples grown, both in the orchard, and of seedlings elsewhere, will prove an effective remedy where this practice is followed generally and uniformly in infested localities.

Borers. The larva of certain insects are called borers because of their habit of boring or tunneling beneath the bark, and even into the wood of trees upon which they feed during this period of their life. They destroy the living bark and sap wood, thus cutting off the connection between the roots and the leaves of the trees, thus injuring or killing them.

The most important of these borers are the following.

The Round-headed Apple tree Borer. This is one of the worst enemies of apple trees, especially near wooded regions. The larva is cylindrical in shape, and bores first into the soft sap wood by making a circular tunnel. It next works into the harder wood, and after nearly three years it emerges, usually several inches above the point of entrance.

Treatment. Before the borer enters the hard wood, it can easily be cut out by using a pointed tool, such as a pruning knife, or (better) punctured with a pointed pliable wire, but after it has

worked its way into the wood, the best method of treatment is to inject a few drops of carbon bisulfide into the tunnel, using a spring bottom oil can for the purpose, and closing the opening of the tunnel with soft clay. This requires no cutting, is speedy and effective, and does not injure the tree.

The Flat-headed Apple Borer. Attacks a variety of trees. This borer makes irregular tunnels in and just beneath the bark, working into the wood only a short distance before pupation.

Treatment: Cut it out by making up and down incisions, as all cuts should be made, rather than crosswise, or crush them in their tunnels by probing with a soft wire. Follow the tunnels until the borer is reached. It is better, because quicker, and less injurious to the trees, to inject the carbon bisulfide.

The Peach tree Borer. This is the caterpillar of a Clearwing moth which deposits her eggs upon the trunk of the tree near the base during midsummer. From these eggs hatch larva, which enter and feed upon the bark of the trunk and larger roots beneath the surface of the soil. Their presence is betrayed by their sawdust like deposits in the wax at the base of the infested tree. They mature in about one year, feeding in both fall and spring, and passing the winter as partially grown larvæ.

Treatment: Remove the earth about the trunk of the tree with a pointed hoe or trowel, and cut out the borers with sharp knife, or crush them in their tunnels with a sharp or stiff wire. One should be careful to remove as little of the living bark as is absolutely necessary. Examine the trees again in two or three days, then mound earth around them about one-half foot high.

Protection of Trees Against Borers: Protective measures, while they will not insure perfect immunity, will often go far toward preventing the infestation of trees by borers. For this purpose an application of one of the following materials should be made about the middle of June and again the middle of August, to the lower eighteen inches or two feet of the tree: (1) Lime-sulfur wash. Boil seventeen pounds of sulfur and twenty-two pounds of lime together, in sufficient water to boil one hour, dilute to about fifty gallons, and apply; or use Commercial Lime-sulfur, at scale strength, with some free sulfur and lime added, or any other lime-sulfur formula, with its sediment, and with as much poison as for the Codling moth. This is especially valuable to prevent the Peach tree borers. (2) Fish Oil Soap, two pounds in one gallon of water. (3) Ordinary soap, made in a thick solution with water. (4) Wrapping the trees with old newspapers carefully tied about them. (5) Frequent white-washing, with ordinary lime whitewash will aid in preventing them. (6) Paint the trunks of all vigorous or healthy

apple, pear and quince trees with pure white lead and raw linseed oil. Care should be taken to cover the trunk completely down to the ground or crown. Remove the earth somewhat, if necessary, at the time of application. Treatment should be made about the middle of June, and repeated in about two months thereafter. Note that these are preventive means, and not remedies.

Mice. These pests girdle trees by gnawing them under the snow. As they will not come above snow to feed, injury is prevented by mounding the trees with earth before freezing in the fall, or by tramping the snow firmly about the tree as soon as it falls. Keep the orchard clean of grass and weeds so that mice cannot find hiding places. Use poisoned baits, traps, cats and dogs. Painting with pure white lead and raw linseed oil or banding with wire netting or wooden veneer protects them.

Rabbits. Damage by rabbits chiefly done when a prolonged snow remains on the ground. Damage by both rabbits and mice is prevented by painting the trunks of trees with pure white lead and raw linseed oil, or by incasing them in something that gives protection, such as wooden veneer, tar paper, or wire screening wrapped into tubes and tied around the trees. Strips of wire cloth, four or five inches wide and two feet long can be cut, and thus rolled the short way around a broom handle, so as to make long open tubes, which are easily slipped around the trees, and give perfect protection. A pair of beagle hounds is valuable in an orchard, and hunting by careful gunners in season should be encouraged, although a careless gunner may shoot fruit trees and destroy them.

Trunks of trees are often protected by trimming off branches to lie on the snow, or project above it, and feed the starving rabbits. Trees are, also, protected by spraying their trunks with lime-sulfur wash during the winter, or spraying with blood, or some other substance offensive to rabbits, as well as by killing a rabbit, cutting it open, and rubbing the trunks of trees with it.

Damaged trees should be coated at once with melted grafting wax, and then covered with clay or a mixture of clay and fresh cow manure, and protected with cloths wrapped around them. Where they are entirely girdled they can be bridge grafted, if this be done early in the spring. In most cases of severe injury to comparatively young trees, it is best to cut them off entirely just above the place of injury.

Peach Leaf Curl. This disease is known wherever peach growing is practiced. It appears to be superinduced by cold, damp weather during April, the time the buds normally start.

The leaf curl spores attack the leaves, branches and blossoms, causing slight deformities on the latter. The characteristic white and red coloring, and distorting of the leaves affected are too well known

to need lengthy description. The enlarged and discolored areas on the leaves are the seat of the disease, and contain the fungus growths which later develop spores. Affected leaves soon drop, and as a result of this defoliation the fruit also drops or is stunted. Twigs attacked by the disease also often die.

Preventive measures for the control of leaf curl consist of spraying the trees with lime-sulfur solution at the strength recommended for San José scale, just prior to the opening of the buds.

By the thorough treatment with this liquid recommended for all peach and plum orchards, the spores of the disease sheltered in the bud scales, and in crevices and elsewhere on other parts of the trees, will be destroyed. It is important to apply this spray within a short time before the buds burst.

Pear Blight. This disease is more commonly noticed while the wigs are making rapid growth during the early part of the season, when the leaves on the affected trees wilt and turn brown, and later black, and remain hanging on the trees. The disease extends from the tip of the twig inward, and finally involves the limbs and the trunk. The same disease may appear on the trunks or larger limbs of the trees, and is often called Body Blight or Canker. Its presence is made known by the roughening, shriveling and blackening of the bark. A well defined line of demarkation separates the diseased from the healthy bark. It infects pear, quince and apple trees, and is known as pear blight, twig blight, black blight, trunk blight, body blight, bark blight, canker, etc.

Treatment: Cut out the diseased twigs and limbs about twelve inches below the diseased tissue. Cut out the patches of diseased bark on the trunk and larger limbs. Sterilize all wounds by painting them over with a strong solution of copper sulfate, one pound to one gallon of water, or corrosive sublimate, one ounce to one gallon of water, or (best) one ounce of formalin in two gallons of water, or paint the cut surfaces with ordinary house paint.

Black Knot. This is a most uncommon and unsightly disease, which attacks plum and cherry trees. It appears on all woody parts of the tree, but mostly on smaller twigs, first as a slight swelling, and later as a rough, knotty excrescence covering the twig from one to five inches or more. As soon as this knot forms a complete ring about the twig or limb, the nutriment of the tip portion is completely cut off, and it dies.

Treatment: Cut out and burn all diseased portions, six or eight inches below the knot during the dormant season, and spray with lime-sulfur solution as recommended for San José scale, and cut out knots during the summer or whenever they appear. Paint over the cut ends with disinfectant solution (see under Pear Blight) or house

paint. Spray with Bordeaux mixture before the buds burst, using three pounds of copper sulfate, five pounds of lime and fifty gallons of water, or with lime-sulfur solution as for San José scale, and follow this with a spray of Bordeaux mixture made by using one-half the above quantity of copper sulfate as soon as the petals drop, and again ten days or two weeks thereafter.

Peach Yellows. The condition known as Yellows is probably the most serious affection of the peach and plum. That it is contagious, spreading in all directions from a focus, is well established. For this reason curative measures are not generally recommended. Affected trees should be removed and destroyed, care being taken to avoid bringing them in contact with healthy trees, as soon as the first definite symptoms of this condition appears.

The first certain sign of the disease is the premature ripening of fruits, which are more or less mottled with red on the outside, and streaked with red within. The sign next in importance in determining the Yellows is the modification of the twig and leaf growth. The leaves of diseased trees will be shorter, narrower, slightly yellow in color, and standing at right angles to the twigs. Suckers often grow in the axils of the leaves, which are set more closely together on the twigs than normally.

The most conspicuous symptom of Yellows is the thick clusters of fine twigs, containing small, red and yellow leaves, closely set, which grow on large limbs and trunks of the trees. Such trees bear, if at all, small, premature, bitter, worthless fruit, and nothing is gained in keeping them on the premises, but they serve as a source of infection for the entire neighborhood. The sooner they are removed the safer it will be for the other peach and plum trees.

Brown Rot. The disease known as brown rot, ripe rot, monilia rot, etc., affects the fruits and even the twigs of stone fruits shortly before and during the time of ripening. It is one of the most destructive pests with which the growers of this class of fruits have to deal. It is characterized by the rotting of the fruits, and begins in dark brown spots attacking first the fruits which hang in clusters, and these spots soon become covered with grayish or ashen colored masses of spores from which the disease spreads. Moist and hot weather is favorable to the spread of this disease.

Preventive treatment should begin during the dormant season, and the first step in the control of this disease is the removal and destruction by burying or burning of the mummied fruits remaining on the affected trees. A thorough spraying, which is equivalent to disinfection with lime-sulfur solution as recommended for San José scale, or Bordeaux mixture, using six pounds of copper sulfate, six pounds of lime and fifty gallons of water, when dormant, will destroy the

spores of the disease. Spores may be carried long distances, however, and treatment as here outlined during the dormant season is not always fully effective to control the disease, and it is recommended that where much damage by monilia rot is likely to occur this treatment should be supplemented by spraying during the summer with either the self-boiled lime-sulfur solution, as recommended by W. M. Scott, of the U. S. Department of Agriculture, made after the formula of eight pounds of sulfur, eight pounds of lime and fifty gallons of water. Too much importance, however, can not be put upon our recommendation for the general treatment of orchards during the dormant season with the lime-sulfur solution at a strength effective in destroying the San José scale.

REPORTS OF EXPENDITURES AND RECEIPTS OF MODEL ORCHARDS FOR THE SEASON OF 1911.

The following reports of expenses incurred in the treatment of orchards or parts of orchards now included in the Model Orchard list and receipts from the sale of fruit from said orchards, have been submitted by the owners, after harvesting this season's crop, and are condensed from records which are as comprehensive and accurate as such reports can well be made. Some of the omissions may, however, be noted here. With few exceptions no account is made of the fruit consumed by the owner and his family friends. Very few items of the value of intercrops or that of cider apples or such fruit as was fed to stock are included in the summary of receipts. If such values were in all cases added to the total receipts these would be increased. On the other hand, no account is taken of the wear and tear of the machinery or the cost of marketing the fruit, and if such were counted it would increase the expenditures. The most important omission of all is a statement of the value of the improved condition of the trees, which cannot well be stated in figures. In many of the orchards included in these records our work was just begun, and the first operation in rejuvenating some of these was to give them a severe pruning, thus cutting away a great part of the bearing wood. Therefore, on such trees little fruit could be expected during the first season. In other orchards conditions were such that several years of treatment will be necessary before even moderate crops can reasonably be expected, but we have no doubt as to the ultimate success of the work. It should be borne in mind that we have not refused to take any orchard offered because of its poor record and run down condition. All orchards have been accepted in the order offered, without regard to condition of the trees, location, or owner. Many were in almost the last stages of existence.

In addition to the improvement of the bearing trees, the increased valuation of the young trees included in these orchards is not taken account of, although the cost of treatment of the young trees is included. This item alone, if possible to estimate, would add often hundreds of dollars to the credit side of a complete account. It is evident, by even the casual examination of the following records, that one of the most valuable assets of the average farm is the old orchard, which previously had not been considered of greater use than to furnish the family with a more or less regular supply of an indifferent grade of fruit for cider, apple butter, vinegar, and other domestic use.

We, therefore, make the comprehensive statement, without fear of contradiction, that all bearing orchards in this State, not actually infected with incurable disease nor located on absolutely the most unfavorable sites, with proper treatment can be made the most profitable areas on the farm. I know of farmers who contract with commercial sprayers to prune and spray their orchard for one half the crop, and receive more and finer fruit from the other half than they formerly got in the whole crop. The letter from a prominent lumberman in Mifflin County expresses briefly but concisely the manner in which orchards respond to our treatment. He writes:

PROF. H. A. SURFACE, Economic Zoologist,
Harrisburg, Pa.

Dear Sir:

The instruction and assistance gives me in reclaiming and rejuvenating my old orchard has been of inestimable value to me. Without this assistance it is doubtful if I could have accomplished in years what I have done in the past season. My orchard yielded this year the largest and finest crop in the neighborhood, and the trees are now in better condition than they ever have been before

Yours truly,

C—— S——.

The following, which is a partial list of abbreviated reports, is preceded by the full report of Mr. W. J. Black which contains all the items on the blank form used for collecting the data of each orchard. All reports are made on these sheets, and the full statement of any of the shorter reports following can be seen on file at this office.

MODEL ORCHARD REPORT OF EXPENSES AND RECEIPTS.

Record of Expenditures and Receipts of the Orchard of.....
 AlexandriaP. O.,Huntingdon County,
Pa.Date.

Number of trees embraced in the orchard treated:

Apple, (young) 1 ; Pear, (young) 25; Peach, (young) 25; Plum, (young) ;
 Cherry, (young) ; Apricot, (young) .
 Apple, (bearing) 25; Pear, (bearing) ; Peach, (bearing) ; Plum, (bearing)
 ; Cherry, (bearing) 25; Quince, (bearing) ; Apricot, (bearing) .

Condition of trees prior to this season's treatment: Bad condition.
 Present condition of trees treated: Fair.

Pruning: Date April, 18.

Number of men at work: 2
 Length of time spent at pruning: 3 days.
 Total number of days: 3 Cost of pruning: \$5.25.

Spraying: (a) For scale insects. Date of spraying: April 19.

Number of men at work: 2
 Length of time spent at spraying: 2 days.
 Total number of days: 4. Cost of labor: \$6.00.
 Cost of spraying materials, Lime: 20 cents. Sulfur: 50 cents.
 Lime-sulfur Solution: gals. at \$

(b) For codling moth and plant diseases. Date: June 3.

Number of men at work: 2
 Length of time spent at spraying: 2 days.
 Total number of days: 2 Cost of labor: \$3.00
 Cost of spraying materials, Arsenate of Lead, 5lbs. at 20 cts. per pound. \$1.00.
 Bordeaux Mixture: Copper Sulfate. lbs. at per pound. \$ Lime: Lime-
 Sulfur Solution:

Fertilizers used:	Cost:
Intercrop, if any:	Cost:
Cultivation:	Cost:
Total expenses,	\$15.95

Receipts.

400 B Apples, box 31 barrel bulk,	\$180.00
Cider, 12 barrels,	36.00
Pears, 25 bushel,	25.00
Peaches,	
Plums,	
Cherries, 640 quarts,	51.20
Quinces,	
Apricots,	
Intercrop,	
Total receipts,	<u>\$272.20</u>

NOTE: Exact figures are desired if obtainable. If not, estimate as close as is possible. Return this report at end of season to

H. A. SURFACE, Economic Zoologist,
 Harrisburg, Pa.

RECORD OF EXPENSES AND RECEIPTS OF MODEL ORCHARDS.

ALLEGHENY COUNTY.

M. C. Dunlevy. Number of trees embraced in the orchard treated: Apple (bearing), 200; Pear (bearing), 35; Cherry (bearing), 75. Cost of pruning: \$18.00. Cost of spraying: \$19.40. Total expenditures: \$37.40. Total receipts: \$772.50.

Hon. Wm. Flinn. Number of trees embraced in the orchard treated: Apple (bearing), 35; Pear (bearing), 20; Peach (bearing), 25; Plum (bearing), 1; Cherry (bearing), 4. Cost of pruning: \$6.00. Cost of spraying: \$9.00. Total expenditures: \$15.00. Total receipts: \$684.20.

Henry T. Magill. Number of trees embraced in orchard treated: Apple (young), 25; Peach (young), 12; Apple (bearing), 10. Cost of pruning: \$3.00. Cost of spraying: \$13.08. Fertilizers: \$8.00. Cultivation: \$3.00. Total expenditures: \$27.08. Total receipts: \$350.00.

A. B. Gilfillan. Number of trees embraced in the orchard treated: Apple (young), 10; Peach (young), 160; Plum (young), 160; Plum (young), 120; Cherry (young), 5; Quince (young), 12; Apple (bearing), 250; Pear (bearing), 10; Peach (bearing), 10; Plum (bearing), 4; Cherry (bearing), 10; Quince (bearing), 2. Cost of pruning: \$20.50. Cost of spraying: \$15.85. Fertilizers: \$12.00. Cultivation: \$15.00. Total expenditures: \$63.35. Total receipts: \$344.40.

ARMSTRONG COUNTY.

J. W. Patterson. Number of trees embraced in the orchard treated: Apple (young), 2; Cherry (young), 2; Apple (bearing), 50; Cherry (bearing), 2. Cost of pruning: \$1.50. Cost of spraying: \$2.00. Fertilizers: \$15.00. Total expenditures: \$18.50. Total receipts: \$427.09.

BEDFORD COUNTY.

Samuel F. Piper. Number of trees embraced in the orchard treated: Apple (young), 300; Pear (young), 2; Apple (bearing), 300; Plum (bearing), 20; Cherry (bearing), 10; Quince (bearing), 10. Cost of pruning: \$15.75. Cost of spraying: \$40.45. Cultivation: \$12.00. Total expenditures: \$68.20. Total receipts: \$381.50.

William Claar. Number of trees embraced in the orchard treated: Apple (young), 325; Cherry (young), 12; Apple (bearing), 220; Pear (bearing), 400; Plum (bearing), 200. Cost of pruning: \$10.00. Cost of spraying: \$49.68. Fertilizers: \$14.00. Total expenditures: \$73.68. Total receipts: \$1,512.68.

Wm. T. Donohue. Number of trees embraced in the orchard treated: Apple (bearing), 25. Cost of pruning: \$16.75. Cost of spraying: \$16.81. Total expenditures: \$33.56. Total receipts: \$1,728.00.

Top Roland. Number of trees embraced in the orchard treated: Apple (young), 6; Pear (young), 2; Peach (young), 70; Cherry (young), 1; Quince (young), 24; Apple (bearing), 194; Peach (bearing), 25; Plum (bearing), 5; Cherry (bearing), 1; Quince (bearing), 3. Cost of pruning: \$6.00. Cost of spraying: \$24.25. Fertilizers: \$13.75. Total expenditures: \$44.00. Total receipts: \$302.00.

BERKS COUNTY.

Bethany Orphans Home. Number of trees embraced in the orchard treated: Apple (bearing), 45; Pear (bearing), 12; Plum (bearing), 20. Cost of spraying: \$36.20. Fertilizers: \$5.00. Total expenditures: \$41.20. Total receipts: \$495.00.

E. M. Zerr. Number of trees embraced in the orchard treated: Apple (young), 400; Pear (young), 8; Plum (young), 10; Apple (bearing), 400; Pear (bearing), 8. Cost of pruning: \$30.00. Cost of spraying: \$102.60. Fertilizers: \$62.00. Cultivation: \$30.00. Total expenditures: \$224.60. Total receipts: \$1,952.00.

BRADFORD COUNTY.

Mrs. Mary Preston. Number of trees embraced in the orchard treated: Apple (bearing), 19; Peach (bearing), 144. Cost of spraying: \$2.35. Fertilizers: \$5.00. Cultivation: \$6.00. Total expenditures: \$13.35. Total receipts: \$6.00.

J. B. Shadduck. Number of trees embraced in the orchard treated: Apple (young), 150; Peach (young), 40; Plum (young), 12; Apple (bearing), 20; Peach (bearing), 20. Cost of pruning: \$12.00. Cost of spraying: \$9.50. Fertilizers: \$16.00. Intercrop: \$5.00. Cultivation: \$20.00. Total expenditures: \$62.50. Total receipts: \$55.50.

F. P. Case. Number of trees embraced in the orchard treated: Apple (young), 24; Apple (bearing), 49. Cost of pruning: \$14.25. Cost of spraying: \$20.00. Total expenditures: \$34.25. Total receipts: \$100.00.

BUCKS COUNTY.

John B. Shoe. Number of trees embraced in the orchard treated: Apple (young), 6; Pear (young), 3; Peach (young), 10; Plum (young), 2; Apple (bearing), 30; Pear (bearing), 3; Peach (bearing), 6. Cost of pruning: \$50.00. Cost of spraying: \$33.66. Total expenditures: \$83.66. Total receipts: \$54.00.

George C. Buckman. Number of trees embraced in the orchard treated: Peach (young), 10; Apple (bearing), 99; Pear (bearing), 20; Peach (bearing), 80. Cost of pruning: \$6.00. Cost of spraying: \$10.15. Fertilizers: \$45.00. Total expenditures: \$51.15. Total receipts: \$121.00.

BUTLER COUNTY.

W. W. Vandivort. Number of trees embraced in the orchard treated: Apple (young), 25; Pear (young), 1; Peach (young), 7; Plum (young), 6; Apple (bearing), 70; Pear (bearing), 4; Peach (bearing), 19; Cherry (bearing), 10. Cost of pruning: \$14.00. Cost of spraying: \$12.70. Fertilizers: \$6.00. Total expenditures: \$32.70. Total receipts: \$225.35.

William Velte. Number of trees embraced in the orchard treated: Apple (young), 300; Pear (young), 300; Peach (young), 200; Plum (young), 750; Cherry (young), 15; Quince (young), 10; Apple (bearing), 500; Pear (bearing), 15; Peach (bearing), 50; Plum (bearing), 25; Cherry (bearing), 50; Quince (bearing), 4. Cost of pruning: \$75.00. Cost of spraying: \$34.00. Fertilizers: \$40.00. Total expenditures: \$149.00. Total receipts: \$3,397.00.

J. J. Riddle. Number of trees embraced in the orchard treated: Apple (young), 125; Pear (young), 6; Peach (young), 40; Plum (young), 50; Apple (bearing), 100; Peach (bearing), 360; Plum (bearing), 12; Cherry (bearing), 25. Cost of pruning: \$20.00. Cost of spraying: \$13.00. Total expenditures: \$33.00. Total receipts: \$526.00.

CARBON COUNTY.

Wilson Dietrich. Number of trees embraced in the orchard treated: Apple (young), 105; Pear (young), 10; Peach (young), 6; Plum (young), 18; Cherry (young), 9; Apple (bearing), 9; Pear (bearing), 7; Cherry (bearing), 6. Cost of pruning: \$3.00. Cost of spraying: \$12.00. Total expenditures: \$15.00.

CLARION COUNTY.

Sidney Shirey. Number of trees embraced in the orchard treated: Apple (young), 30; Pear (young), 10; Peach (young), 20; Plum (young), 20; Cherry (young), 10; Apple (bearing), 8; Peach (bearing), 10; Plum (bearing), 20; Cherry (bearing), 10. Cost of pruning: \$4.50. Cost of spraying: \$4.40. Fertilizers: \$14.00. Total expenditures, \$22.90. Total receipts: \$22.50.

CLINTON COUNTY.

C. B. Grieb. Number of trees embraced in the orchard treated: Apple (young), 115; Pear (young), 5; Peach (young), 400; Apple

(bearing), 60; Pear (bearing), 5; Peach (bearing), 60; Cherry (bearing), 7; Quince (bearing), 3. Cost of pruning: \$6.00. Cost of spraying: \$20.40. Fertilizers: \$10.00. Total expenditures: \$36.40. Total receipts: \$299.00.

COLUMBIA COUNTY.

Henry C. Barton. Number of trees embraced in the orchard treated: Apple (bearing), 87; Cherry (bearing), 3. Cost of pruning: \$18.00. Cost of spraying: \$25.20. Fertilizers: \$12.00. Cultivation: \$1.75. Total expenditures: \$56.95. Total receipts: \$469.60.

Hon. Wm. T. Creasy. Number of trees embraced in the orchard treated: Apple (bearing), 150; Pear (bearing), 60; Peach (bearing), 250; Plum (bearing), 10. Cost of pruning: \$6.00. Cost of spraying: \$34.65. Fertilizers: \$30.00. Cultivation: \$5.00. Total expenditures: \$75.65. Total receipts: \$1,581.50.

ELK COUNTY.

Joseph Lanzel. Number of trees embraced in the orchard treated: Apple (young), 100; Apple (bearing), 50; Pear (bearing), 2; Cherry (bearing), 10. Cost of pruning: \$6.00. Cost of spraying: \$10.88. Fertilizers: \$9.34. Total expenditures: \$26.22. Total receipts: \$138.00.

FAYETTE COUNTY.

Elza Warman. Number of trees embraced in the orchard treated: Apple (young), 1; Cherry (young), 1. Cost of pruning: \$3.00. Cost of spraying: \$5.40. Total expenditures: \$8.40. Total receipts: \$33.00.

FOREST COUNTY.

H. H. Harp. Number of trees embraced in the orchard treated: Apple (young), 6; Apple (bearing), 100; Pear (bearing), 10; Peach (bearing), 5; Plum (bearing), 10. Cost of pruning: \$18.00. Cost of spraying: \$39.32. Fertilizers: \$20.00. Intercrop: \$35.00. Cultivation: \$10.00. Total expenditures: \$122.32. Total receipts: \$241.75.

FRANKLIN COUNTY.

Number of trees embraced in the orchard treated: Apple (young), 4; Pear (young), 2; Apple (bearing), 32; Pear (bearing), 8. Cost of pruning: \$3.75. Cost of spraying: \$6.68. Total expenditures: \$10.43. Total receipts: \$87.50.

P. N. Amberson. Number of trees embraced in the orchard treated: Apple (young), 6; Apple (bearing), 44. Cost of pruning: \$6.00. Cost of spraying: \$11.26. Total expenditures: \$17.26. Total receipts: \$56.25.

E. S. Rinehart. Number of trees embraced in the orchard treated: Peach (young) 2,500; Apple (bearing), 100; Peach (bearing), 2,500. Cost of pruning: \$20.00. Cost of spraying: \$48.00. Total expenditures: \$68.00. Total receipts: \$500.00.

Irvin C. Elder, Esq. Number of trees embraced in the orchard treated: Apple (young), 4; Apple (bearing), 33. Cost of pruning: \$3.00. Cost of spraying: \$7.65. Total expenditures: \$10.65. Total receipts: \$399.00.

Mercersburg Academy. Number of trees embraced in the orchard treated: Apple (bearing), 34; Pear (bearing), 6; Plum (bearing), 5. Cost of pruning: \$3.00. Cost of spraying: \$6.25. Fertilizers: \$3.00. Total expenditures: \$12.25. Total receipts: \$30.00.

FULTON COUNTY.

R. J. McCandlish. Number of trees embraced in the orchard treated: Apple (young), 12; Peach (young), 2; Apple (bearing), 30; Pear (bearing), 2; Peach (bearing), 5; Cherry (bearing), 3. Cost of pruning: \$5.25. Cost of spraying: \$9.90. Total expenditures: \$15.15. Total receipts: \$150.00.

J. B. Runyan. Number of trees embraced in the orchard treated: Apple (young), 1; Pear (young), 1; Peach (young), 4; Plum (young), 2; Cherry (young), 2; Apple (bearing), 16; Pear (bearing), 1. Cost of pruning: 90. Cost of spraying: \$2.75. Total expenditures: \$3.65. Total receipts: \$15.50.

INDIANA COUNTY.

Jos. M. Martin. Number of trees embraced in the orchard treated: Peach (young), 50; Cherry (young), 6; Apple (bearing), 75; Pear (bearing), 6; Peach (bearing), 25; Plum (bearing), 6; Cherry (bearing), 20. Cost of pruning: \$15.00. Painting trunks: \$1.00. Fertilizers: \$10.00. Total expenditures: \$26.00. Total receipts: \$139.00.

LANCASTER COUNTY.

Frank J. Trout. Number of trees embraced in the orchard treated: Apple (young), 4; Peach (young), 10; Apple (bearing), 24; Pear (bearing), 8; Quince (bearing), 4. Cost of pruning: \$1.80. Cost of spraying: \$12.30. Total expenditures: \$14.10. Receipts: Not much fruit. Young trees.

Hon. Chas. I. Landis. Number of trees embraced in the orchard treated: Apple (young), 4; Peach (young), 5; Pear (bearing), 2; Peach (bearing), 4. Cost of pruning: \$3.00. Cost of spraying: \$4.10. Total expenditures: \$7.10. Total receipts: \$20.00.

Clayton R. Farmer. Number of trees embraced in the orchard treated: Apple (young), 4; Apple (bearing), 18; Pear (bearing), 1; Peach (bearing), 4. Cost of pruning: \$1.50. Cost of spraying: \$9.22. Total expenditures: \$10.72. Total receipts: \$400.00.

Prof. John H. Shenck. Number of trees embraced in the orchard treated: Apple (young), 25; Peach (young), 15; Apple (bearing), 28. Cost of pruning: \$2.70. Cost of spraying: \$7.40. Total expenditures: \$10.10. Total receipts: \$100.00.

H. F. Ruhl. Number of trees embraced in the orchard treated: Apple (young), 155; Peach (young), 33; Plum (young), 4; Cherry (young), 5; Quince (young), 6; Apple (bearing), 10. Cost of pruning: \$4.50. Cost of spraying: \$3.23. Total expenditures: \$7.73. Total receipts: \$3.00.

Dr. F. Winger's Estate. Number of trees embraced in the orchard treated: Apple (young), 7; Peach (young), 6; Apple (bearing), 40. Cost of pruning: \$3.00. Cost of spraying: \$9.27. Fertilizers: \$4.00. Total expenditures: \$16.27. Total receipts: \$90.00.

S. E. Ebersole. Number of trees embraced in the orchard treated: Apple (young), 20; Pear (young), 4; Peach (young), 100; Apple (bearing), 15; Pear (bearing), 4; Peach (bearing), 500. Cost of pruning: \$5.00. Cost of spraying: \$20.00. Fertilizers: \$16.00. Inter-crop: \$4.00. Cultivation: \$5.00. Total expenditures: \$50.00. Total receipts: \$85.00.

LAWRENCE COUNTY.

J. Audley Boak. Number of trees embraced in the orchard treated: Apple (bearing), 320; Peach (bearing), 12; Plum (bearing), 10; Cherry (bearing), 12; Quince (bearing), 2. Cost of pruning: \$80.00. Cost of spraying: \$17.60. Fertilizers: \$25.00. Total expenditures: \$122.60. Total receipts: \$800.00.

C. C. Cox. Number of trees embraced in the orchard treated: Apple (young), 25; Plum (young), 3; Apple (bearing), 35; Pear (bearing), 7; Peach (bearing), 75; Plum (bearing), 80; Cherry (bearing), 25. Total expenditures: \$22.25. Total receipts: \$427.00.

LEBANON COUNTY.

J. W. Mohler. Number of trees embraced in the orchard treated: Apple (young), 712; Pear (young), 2; Peach (young), 825; Plum (young), 3; Apricot (young), 2; Quince (young), 1. Total expenditures: \$60.00. Total receipts: \$436.00.

John G. Eisenhower. Number of trees embraced in the orchard treated: Apple (young), 11; Pear (young), 14; Peach (young) 500; Plum (young), 11; Cherry (young), 16; Quince (young), 3; Apricot (young), 10; Apple (bearing), 35; Pear (bearing), 4; Peach (bearing), 200; Plum (bearing), 3; Cherry (bearing), 4; Quince (bearing), 3; Apricot (bearing), 1. Total expenditures: \$59.55. Total receipts: \$521.70.

James M. Bohn. Number of trees embraced in the orchard treated: Apple (bearing), 36; Pear (bearing), 4; Plum (bearing), 3. Cost of pruning: \$3.00. Cost of spraying: \$13.32. Total expenditures: \$16.32. Total receipts: \$77.50.

Noah P. Walborn. Number of trees embraced in the orchard treated: Apple (young), 30; Peach (young), 25; Cherry (young), 8;

Quince (young), 6; **Apple** (bearing), 70; **Pear** (bearing), 6; **Cherry** (bearing), 6. Cost of pruning: \$4.50. Cost of spraying: \$33.71. Fertilizers: \$21.50. Total expenditures: \$59.71. Total receipts: \$495.00.

LEHIGH COUNTY.

Fred S. Dickenshied. Number of trees embraced in the orchard treated: **Apple** (bearing), 88. Cost of pruning: \$5.00. Cost of spraying: \$14.30. Fertilizers: \$3.00. Intercrop: \$4.00. Total expenditures: \$26.30. Total receipts: \$137.00.

LYCOMING COUNTY.

A. G. Decker. Number of trees embraced in the orchard treated: **Apple** (bearing), 112. Cost of pruning: \$24.00. Cost of spraying: \$17.50. Fertilizers: \$7.50. Intercrop: \$20.00. Cultivation: \$10.00. Total expenditures: \$79.00. Total receipts: \$182.00.

Henry E. Warner. Number of trees embraced in the orchard treated: **Apple** (young), 65; **Peach** (young), 190; **Plum** (young), 6; **Cherry** (young), 30; **Apple** (bearing), 16; **Pear** (bearing), 9; **Peach** (bearing), 200; **Cherry** (bearing), 16. Cost of pruning: \$6.00. Cost of spraying: \$13.85. Fertilizers: \$8.00. Total expenditures: \$27.85. Total receipts: \$70.00.

Sheadle Sisters. Number of trees embraced in the orchard treated: **Apple** (young), 135; **Pear** (young), 50; **Peach** (young), 60; **Cherry** (young), 425; **Quince** (young), 10; **Apple** (bearing), 75; **Pear** (bearing), 7; **Plum** (bearing), 50. Cost of pruning: \$6.00. Cost of spraying: \$22.05. Fertilizers: \$68.00. Intercrop: \$20.00. Cultivation: \$1.00. Total expenditures: \$117.05. Total receipts: \$429.00.

E. M. Snyder. Number of trees embraced in the orchard treated: **Apple** (bearing), 35. Fertilizers: \$8.00. Intercrop: \$10.00. Cultivation: \$5.00. Total expenditures: \$23.00. Total receipts: \$60.00.

W. G. Winner. Number of trees embraced in the orchard treated: **Apple** (bearing), 121. Cost of pruning: \$3.00. Cost of spraying: \$11.72. Fertilizers: \$15.60. Cultivation: \$27.00. Picking: \$40.00. Total expenditures: \$97.32. Total receipts: \$525.00.

J. W. Heilman. Number of trees embraced in the orchard treated: **Apple** (young), 10; **Pear** (young), 5; **Plum** (young), 8; **Cherry** (young), 3; **Apple** (bearing), 35. Cost of pruning: \$6.00. Cost of spraying: \$14.25. Fertilizers: \$4.75. Total expenditures: \$25.00. Total receipts: \$126.00.

MERCER COUNTY.

George Junior Republic. Number of trees embraced in the orchard treated: **Apple** (young), 12; **Pear** (young), 2; **Peach** (young), 8; **Apple** (bearing), 74; **Plum** (bearing), 3. Total expenditures: \$31.00. Total receipts: \$385.48.

Dr. T. B. Roth. Number of trees embraced in the orchard treated: Apple (young), 35; Pear (young), 10; Peach (young), 50; Plum (young), 10; Cherry (young), 10; Apple (bearing), 15; Pear (bearing), 10; Peach (bearing), 10; Plum (bearing), 20; Cherry (bearing), 6. Cost of pruning: \$10.00. Cost of spraying: \$5.56. Total expenditures: \$15.56. Total receipts: \$135.00.

J. R. Partridge. Number of trees embraced in the orchard treated: Apple (bearing), 6; Pear (bearing), 50; Plum (bearing), 60. cost of pruning: \$4.50. Cost of spraying: \$4.18. Total expenditures: \$8.68. Total receipts: \$88.50.

Daniel Redfoot. Number of trees embraced in the orchard treated: Apple (young), 25; Pear (young), 2; Peach (young), 25; Plum (young), 10; Cherry (young), 20; Quince (young), 3; Apple (bearing), 100; Pear (bearing), 5; Peach (bearing), 10; Plum (bearing), 14; Cherry (bearing), 25; Quince (bearing), 3. Cost of pruning: \$10.00. Cost of spraying: \$26.52. Total expenditures: \$36.52. Total receipts: \$543.05.

MONTOUR COUNTY.

State Hospital for Insane. Number of trees embraced in the orchard treated: Apple (young), 23; Pear (young), 21; Apple (bearing), 133; Pear (bearing) 23. Cost of pruning: \$18.00. Cost of spraying: \$25.30. Cultivation: \$1.05. Total expenditures: \$44.35. Total receipts: \$510.00.

MONROE COUNTY.

H. B. Decker. Number of trees embraced in the orchard treated: Apple (young), 8; Peach (young), 6; Apple (bearing), 50; Peach (bearing), 6. Cost of pruning: \$3.00. Cost of spraying: \$9.10. Fertilizers: \$3.00. Total expenditures: \$15.10. Total receipts: \$99.00.

NORTHAMPTON COUNTY.

Enoch Reimer. Number of trees embraced in the orchard treated: Apple (young), 13; Pear (young), 1; Cherry (young), 8; Apple (bearing), 40. Cost of pruning: 4.50. Cost of spraying: \$20.50. Fertilizers: \$5.50. Intercrop: \$2.00. Cultivation: \$3.00. Picking apples: \$10.00. Total expenditures: \$45.50. Total receipts: \$214.15.

NORTHUMBERLAND COUNTY.

Percy N. Swank. Number of trees embraced in the orchard treated: Apple (young), 40; Pear (young), 12; Peach (young), 185; Plum (young), 15; Cherry (young), 15; Quince (young), 7; Apple (bearing), 175; Pear (bearing), 15; Plum (bearing), 12; Cherry (bearing),

25. Cost of pruning: \$16.50. Cost of spraying: \$25.45. Fertilizers: \$46.00. Cultivation: \$15.00. Total expenditures: \$102.95. Total receipts: \$465.00.

H. A. Lawrence. Number of trees embraced in the orchard treated: Apple (young), 275; Pear (young), 75; Peach (young), 250; Plum (young), 75; Cherry (young), 6; Quince (young), 25; Apple (bearing), 14; Pear (bearing), 2; Peach (bearing), 4; Plum (bearing), 2. Cost of pruning: \$9.00. Cost of spraying: \$15.19. Fertilizers: \$7.50. Cultivation: \$10.00. Total expenditures: \$41.69. Total receipts: \$200.50.

Percy W. Hastings. Number of trees embraced in the orchard treated: Peach (young), 40; Apple (bearing), 180. Cost of pruning: \$19.50. Cost of spraying: \$30.00. Fertilizers: \$60.00. Intercrop: \$20.00. Cultivation: \$16.50. Total expenditures: \$146.00. Total receipts: \$550.00.

Charles N. Marsh. Number of trees embraced in the orchard treated: Apple (young), 10; Pear (young), 7; Peach (young), 20; Apple (bearing), 40; Pear (bearing), 5; Quince (bearing), 4. Cost of pruning: \$1.50. Cost of spraying: \$3.83. Total expenditures: \$5.33. Total receipts: \$54.80.

J. K. Rissel. Number of trees embraced in the orchard treated: Apple (young), 10; Peach (young), 20; Apple (bearing), 25; Pear (bearing), 7; Peach (bearing), 2. Cost of pruning: \$6.00. Cost of spraying: \$8.65. Intercrop: \$5.00. Cultivation: \$5.00. Total expenditures: \$24.65. Total receipts: \$98.50.

W. L. Mettler. Number of trees embraced in the orchard treated: Apple (bearing), 75; Pear (bearing), 20; Peach (bearing), 100; Plum (bearing), 10; Cherry (bearing), 7. Cost of pruning: \$12.00. Cost of spraying: \$45.10. Cultivation: \$36.00. Total expenditures: \$93.10. Total receipts: \$365.00.

SCHUYLKILL COUNTY.

Irvin E. Teter. Cost of pruning: \$12.00. Cost of spraying: \$11.20. Cultivation: \$11.00. Total expenditures: \$34.20. Total receipts: \$436.25.

SNYDER COUNTY.

C. L. Kremer. Total expenditures: \$50.00. Total receipts: \$97.50.

Dr. Percival Herman. Number of trees embraced in the orchard treated: Apple (young), 5; Pear (young), 5; Cherry (young), 10; Apple (bearing), 23; Pear (bearing), 32; Peach (bearing), 1; Plum (bearing), 16; Cherry (bearing), 12. Cost of pruning: \$1.50. Cost of spraying: \$4.65. Cultivation: \$1.00. Total expenditures: \$7.15. Total receipts: \$47.36.

W. W. Bruner. Number of trees embraced in the orchard treated: Apple (young), 400; Peach (young), 500; Cherry (young), 200; Peach

(bearing), 1,000. Cost of pruning: \$20.00. Cost of spraying: \$29.50. Fertilizers: \$45.00. Cultivation: \$40.00. Total expenditures: \$134.50. Total receipts: \$1,281.50.

SOMERSET COUNTY.

D. W. Will. Number of trees embraced in the orchard treated: Apple (bearing), 25; Pear (bearing), 3; Peach (bearing), 2. Cost of pruning: \$4.50. Cost of spraying: \$21.27. Cultivation: \$16.77. Total expenditures: \$35.58. Total receipts: \$127.00.

Daniel Ott. Number of trees embraced in the orchard treated: Apple (young), 30; Pear (young), 20; Plum (young), 8; Cherry (young), 7; Quince (young), 3; Apple (bearing), 200; Pear (bearing), 23; Peach (bearing), 4; Plum (bearing), 30; Cherry (bearing), 15. Cost of pruning: \$9.00. Cost of spraying: \$13.95. Fertilizers: \$26.00. Total expenditures: \$48.95. Total receipts: \$1,561.60.

J. P. Rhoads. Number of trees embraced in the orchard treated: Apple (bearing), 50. Cost of pruning: \$2.25. Cost of spraying: \$4.15. Total expenditures: \$6.40. Total receipts: \$250.00.

UNION COUNTY.

B. S. Schoch. Number of trees embraced in the orchard treated: Apple (young), 27; Cherry (young), 8; Quince (young), 6; Apple (bearing), 12. Cost of pruning: \$1.25. Cost of spraying: \$5.60. Fertilizers: \$5.00. Total expenditures: \$11.85. Total receipts: \$37.25.

J. Newton Glover. Number of trees embraced in the orchard treated: Apple (young), 50; Pear (young), 4; Peach (young), 4; Plum (young), 8; Cherry (young), 2; Quince (young), 2; Apricot (young), 1; Apple (bearing), 90; Pear (bearing), 4; Peach (bearing), 2; Plum (bearing), 5; Cherry (bearing), 2; Apricot (bearing), 1. Cost of pruning: \$10.00. Cost of spraying: \$54.25. Total expenditures: \$64.25. Total receipts: \$161.31.

WARREN COUNTY.

W. C. Averill. Number of trees embraced in the orchard treated: Apple (young), 5; Pear (young), 2; Peach (young), 5; Plum (young), 6; Cherry (young), 6; Apple (bearing), 60; Pear (bearing), 7; Peach (bearing), 15; Plum (bearing), 1; Cherry (bearing), 12. Cost of pruning: \$10.50. Cost of spraying: \$15.40. Total expenditures: \$25.90. Total receipts: \$65.40.

WAYNE COUNTY.

W. J. P. Warwick. Number of trees embraced in the orchard treated: Apple (bearing), 23. Cost of pruning: \$5.00. Cost of spraying: \$4.94. Cultivation: \$7.50. Total expenditures: \$17.44. Total receipts: \$3.75.

WYOMING COUNTY.

W. L. Utley. Number of trees embraced in the orchard treated: Apple (bearing), 97; Pear (bearing), 3. Cost of pruning: \$10.00. Cost of spraying: \$7.90. Cultivation: \$18.00. Total expenditures: \$35.90. Total receipts: \$64.50.

G. L. Hadsall. Number of trees embraced in the orchard treated: Apple (young), 147; Pear (young), 5; Peach (young), 50; Plum (young), 12; Cherry (young), 8; Apple (bearing), 80; Pear (bearing), 4; Plum (bearing), 5; Cherry (bearing), 4. Cost of pruning: \$13.50. Cost of spraying: \$22.23. Fertilizers: \$30.00. Total expenditures: \$65.73. Total receipts: \$368.50.

YORK COUNTY.

C. A. Hawkins. Number of trees embraced in the orchard treated: Apple (young), 600; Peach (young), 1,700; Quince (young), 60; Apple (bearing), 25; Peach (bearing), 175. Cost of pruning: \$31.50. Cost of spraying: \$40.63. Fertilizers: \$130.00. Intercrop: \$270.00. Cultivation: \$70.00. Total expenditures: \$542.13. Total receipts: \$1,110.90.

Wm. H. Sweitzer. Number of trees embraced in the orchard treated: Apple (bearing), 40. Cost of pruning: \$3.00. Cost of spraying: \$24.25. Fertilizers: \$6.00. Cultivation: \$2.00. Total expenditures: \$35.25. Total receipts: \$278.40.

Wm. N. Zeigler. Number of trees embraced in the orchard treated. Peach (young), 115; Apple (bearing), 34. Cost of pruning: \$9.00. Cost of spraying: \$17.88. Fertilizers: \$10.00. Total expenditures: \$36.88. Total receipts: \$260.38.

The sum total for the expenditures of seventy-five orchards mentioned above is \$3,971.24, and the sum total of the receipts is \$32,199.35. As the benefits of the demonstration and supervision work reached over seven hundred and fifty orchards in this State during the past year it is evident that the income from this feature of the work alone was over \$300,000.00. Thus is returned to the citizens of this State in a practical way over thirty times the amount expended by the State to procure such results, in addition to the increased value of the trees, due to increased healthfulness, and also in addition the value of the information that was so widely disseminated in the Model Orchards.

 NURSERY INSPECTION.

The growing of nursery stock is an industry of great and increasing importance in this State. There are at present over two hundred individuals and firms engaged in the business of growing young trees.

shrubs, vines and plants for sale, and the aggregate acreage under cultivation for this purpose now exceeds two thousand acres.

All nursery stock grown in this State is subject to examination by the inspectors of the Division of Zoology working under the direction of the Department of Agriculture, and inspections are made twice each year. The first annual inspection begins in August, and is completed before the fall shipment of stock by nurseries begins. The second is made in November and December after the leaves have dropped and there is no longer any danger of the spread of insect pests during the season.

Under the terms of the Act of Assembly governing the sale of nursery stock in this State, no person is allowed to do business as a nurseryman except such as are granted a certificate by the Department of Agriculture, after his stock has been examined and found free from all injurious insects pests and diseases. When such pests and diseases are found the most careful efforts are made to insure the destruction of affected plants, and fumigation of all stock to be sold or shipped from the nurseries in which these pests have been found.

While fumigation is not demanded in nurseries found free from insect pests, all nurserymen are strongly recommended to fumigate all stock liable to infection, as a special safeguard against the possibility of spreading pests. By this treatment insects concealed under ground on roots, such as the Woolly aphid, and even Borers will be destroyed.

It has been found possible to grow absolutely clean and healthy nursery stock in this State by following the directions of this office, and thus safeguarding the interests of nurserymen and planters alike. The Department of Agriculture protects the nurserymen and aids him in his efforts to avoid infestation by compelling the destruction or treatment of infested trees and shrubbery located near nurseries, at all times.

There is no better season at which to treat trees and shrubbery in the nursery than at the present time (during the dormant season), and it is urged that all stock subject to infestation by San José scale and other scale insects, be sprayed with lime-sulfur solution at the strength recommended for the treatment of orchards. If the clear, concentrated solution be used, there will be no traces left upon the stock, to show that it has been sprayed. At any rate, the prejudice which was believed to have existed some years ago against young trees showing marks of lime-sulfur treatment, on the ground that they have been infested, now in a large measure no longer exists.

The following is a list of the nurseries inspected and licensed in the State of Pennsylvania, giving the name, address, area of planted nursery stock, and certificate number of each:

ADAMS COUNTY.

Taylor & Heckenluber,	Biglerville,	14	1739
W. W. Boyer & Bro.,	Arendtsville,	14	1740
E. P. Garretson,	Biglerville,	4	1751
H. G. Baugher, Propr. The Adams Co. Nursery,	Aspers,	20	1750
C. A. Stoner,	Gettysburg,	4	1754
Charles J. Wilson, R. F. D.,	Gettysburg,	4	1738
H. R. Plank,	York Springs,	5	1748
Cornelius Bender, R. D. No. 2,	Aspers,	4	1749
Hartman & Minter,	Cashtown,	2	1735
C. A. Hartman,	Cashtown,	24	1736
Geo. Oyler,	Gettysburg,	3	1737
Harry Pitzer,	Aspers,	4	1902

ALLEGHENY COUNTY.

Elliott Nursery Co.,	Springdale,	30	1867
August G. Espe, R. D. No. 1,	Perryville,	4	1730

BEAVER COUNTY.

James W. Mackall,	Beaver,	6	1731
R. C. Mackall,	Beaver,	6	1732
A. P. Goodwin,	Industry,	3	1745

BEDFORD COUNTY.

Austin Wright,	Alum Bank,	1	1766
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BERKS COUNTY.

A. L. Wenrich,	Robesonia,	4	1901
Bertrand H. Farr,	Wyomissing,	5	1881

BLAIR COUNTY.

Geo. S. Burket,	Claysburg,	1	1733
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BUTLER COUNTY.

Pierce Bros.,	Butler,	6	1728
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BUCKS COUNTY.

J. L. Lovett,	Emilie,	5	1924
Henry Palmer,	Langhorne,	2	1813
Horace Janney,	Newtown,	6	1823
D. Landreth Seed Co.,	Bristol,	2	1824
The W. H. Moon Co.,	Morrisville,	450	1802
Morrisville Nurseries,	Morrisville,	40	1825
M. A. Youngken,	Richlandtown,	1	1907
Jacob F. Krout, R. D. No. 1,	Perkasie,	2	1911
Penna. R. R. Co., Forestry Department, E. A. Sterling, Forester, Philadelphia, Pa. Nursery near,	Morrisville,	40	1834

CENTRE COUNTY.

State College, Department of Horticulture,	State College,	1	1796
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CHESTER COUNTY.

James Donoghue,	Kenett Square,	24	1889
W. H. Doyle,	Berwyn,	10	1797
The Morris Nursery Co.,	West Chester,	200	1759
The Conard & Jones Co.,	West Grove,	20	1816
The Dingee & Conard Co.,	West Grove,	12	1815
The Rakestraw Pyle Co.,	Kennett Square,	150	1807
J. A. Roberts,	Malvern,	20	1864
Hoopes Bro. & Thomas Co.,	West Chester,	560	1758

*Grow berry or small fruit plants only.

CHESTER COUNTY—Continued.

J. B. Reif,	Spring City,	1	1798
E. B. Keating,	Kennett Square,	1	1888
Louis B. Eastburn,	Kennett Square,	5	1826
E. W. Twandell, (1212 Market St., Phila- delphia, Pa.)	Westtown,	2	1832
H. H. Corson & Son,	Avondale,	1	1817
Milton Clevensline,	Kimberton,	1	1801

CLEARFIELD COUNTY.

W. S. Wright,	Clearfield,	1	1784
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COLUMBIA COUNTY.

Philip Harris, R. F. D.,	Light Street,	1	1837
T. D. Robbins,	Light Street,	1	1839
Frank Harris,	Light Street,	1	1838

CRAWFORD COUNTY.

*David Kelty,	Cochrannton,	11	1906
*Bailey Bros., R. D. No. 66,	Cochrannton,	13	1762
*Henry Roberts, R. D. No. 66,	Cochrannton,	7	1790
*J. T. Reed, R. D. No. 66,	Cochrannton,	11	1793
*Samuel J. Cooper, R. D. No. 58,	Cochrannton,	2	1898
*Lewis E. Swogger, R. D. No. 28,	Carlton,	1	1794
*J. O. Marsh,	Geneva,	8	1763
*Peter Schaffner, R. D. No. 2,	Meadville,	11	1764
*D. H. Lefever, R. D. No. 2,	Meadville,	1	1905

CUMBERLAND COUNTY.

B. F. Cocklin, R. D. No. 2,	Mechanicsburg,	3	1910
R. A. Wiskersham,	Mechanicsburg,	40	1920

DAUPHIN COUNTY.

*M. S. Brinser,	Middletown,	2	1897
The Berryhill Nursery Co.,	Harrisburg,	8	1868
C. P. Scholl, R. D. No. 1,	Halifax,	5	1869
*Andrew Coble, R. D. No. 1,	Middletown,	5	1896
C. B. Landis,	Penbrook,	1	1874
J. M. Christman,	Fort Hunter,	1	1899
T. A. Woods,	Harrisburg,	1	1900
J. R. Snavelly,	Harrisburg,	1	1903
*Theadore Burris,	Royalton,	1	1922
*Edward W. Creep, 460 Spruce St.,	Middletown,	1	1923

DELAWARE COUNTY.

P. Z. Supplee & Son,	Collingdale,	10	1814
J. J. Styer,	Concordville,	2	1893
M. J. Porter,	Wayne,	3	1892
C. H. Pettiford,	Lansdowne,	1	1894
W. E. Caum, (Lessee),	Haverford,	4	1819
John G. Gardner,	Bryn Mawr,	7	1821
H. H. Battles,	Newtown Square,	5	1809
Otto Lochman,	Wallingford,	1	1891

ERIE COUNTY.

*Harry Youngs, R. D. No. 2,	North East,	5	1778
*M. B. Geer,	Girard,	5	1765
Penna. Nursery Co.,	Girard,	50	1795
L. C. Hall,	Avonia,	1	1768
H. C. Pettis,	Plataea,	1	1783
*A. F. Youngs, R. D. No. 2,	North East,	2	1771
*Orton Bros.,	North East,	1	1772
*D. C. Bostwick & Son,	North East,	1	1776
L. G. Youngs,	North East,	4	1773
*M. E. Kelly, R. D. No. 2,	North East,	2	1775
*W. E. Smith, R. D. No. 2,	North East,	3	1786

*Grow berry or small fruit plants only.

ERIE COUNTY—Continued.

*J. G. Bagley, R. D. No. 3,	North East,	1	1774
*W. S. Waldo,	North Girard,	2	1769
*Perry Goodrich,	North East,	2	1785
*F. K. Taber,	North East,	2	1787
Stark Bros. Nurseries & Orchards Co., ..	North Girard,	100	1767
S. J. Allis, R. D. No. 8,	Erie,	1	1875

FRANKLIN COUNTY.

Penna. Department of Forestry, Tom O.			
Brietsch, (Forester), Mont Alto Nurs-			
ery,	Mt. Alto,	5	1870
Henry Eicholz,	Waynesboro,	1	1904
Penna. Department of Forestry, Robt. G.			
Conklin, (Forester), Caledonia Nursery, Fayetteville,		1	1871

FULTON COUNTY.

*Frank P. Pleisinger,	Locust Grove,	2	1734
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JUNIATA COUNTY.

*John K. Oberholtzer,	Mifflintown,	11	1841
*S. H. Graybill,	Richfield,	6	1843
*Wm. Banks,	Mifflintown,	8	1845
*John H. Shellenberger,	McAllisterville,	6	1842
*C. S. Winey,	McAllisterville,	21	1844
*C. G. Pellman,	Richfield,	31	1863

LACKAWANNA COUNTY.

*Elmer E. Richards,	Baldmount,	1	1860
John W. Shephard, 945 Clay Ave.,	Scranton,	4	1866
Daniel O'Hara,	Dunmore,	1	1876

LANCASTER COUNTY.

John G. Engle,	Marietta,	1	1913
Maurice J. Brinton,	Christiana,	10	1873
W. P. Bolton,	Holtwood,	2	1890
D. D. Herr,	Lancaster,	15	1804
Wilson Kready,	Mt. Joy,	1	1916
O. W. Laushey,	Bird-in-Hand,	3	1805
A. W. Root & Bro., R. D. No. 1,	Manheim,	25	1806
David S. Herr, R. D. No. 7,	Lancaster,	12	1761
M. H. Musser,	Lancaster,	3	1760
B. F. Barr & co.,	Lancaster,	3	1914
Frank A. Suter,	Lancaster,	1	1912
John G. Rush,	West Willow,	1	1895

LAWRENCE COUNTY.

Butz Bros.,	New Castle,	1	1741
A. S. Moore,	New Castle,	1	1746

LEHIGH COUNTY.

Lehigh Nurseries,	Allentown,	2	1872
*Preston J. Kline,	Coopersburg,	2	1909

LUZERNE COUNTY.

Miss M. A. Maffett,	Wilkes-Barre,	1	1859
Bonsey & Rifkin,	Wilkes-Barre,	1	1861
E. B. Wheeler,	Wyoming,	1	1862
Warren E. Straw,	Wilkes-Barre,	1	1925

MERCER COUNTY.

*H. H. McClearn,	Stoneboro,	4	1854
*D. C. McClearn,	Stoneboro,	1	1853
*Geo. W. Proud,	Stoneboro,	2	1848
*W. M. Doyle,	Stoneboro,	7	1791
*Robert Doyle,	Stoneboro,	4	1850
*J. W. Nelson,	Volant,	4	1742
*Geo. F. Brocklehurst, R. D. No. 20,	Jackson Centre,	5	1849
*J. T. McLean, R. D. No. 16,	Greenville,	1	1847
J. L. Hoobler & Son, R. D. No. 34,	Hadley,	2	1744
*W. R. Cribbs,	Mercer,	2	1781
*H. W. Allison, R. D. No. 9,	Mercer,	3	1780
*J. E. Brocklehurst,	Mercer,	1	1851
Hugh Hogue, R. D.,	Carlton,	2½	1792

MIFFLIN COUNTY.

Penna. Department of Forestry, Geo. A. Retan, (Forester), Nursery and Forest Reservation near Greenwood, Hunting- don Co., Pa.,	Belleville,	2	1855
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MONTGOMERY COUNTY.

Chris Koehler,	Cheltenham,	2	1918
R. B. Haines Co.,	Cheltenham,	10	1831
J. B. Heckler,	Lansdale,	4	1856
J. W. Thomas & Sons,	King of Prussia,	90	1822
J. Krewson & Sons,	Cheltenham,	25	1808
J. B. Moore,	Hatfield,	5	1852
Adolph Mueller,	Norristown,	12	1799
Thomas Meehan & Sons,	Dresher,	215	1803
Wm. Sturzebecher,	Lansdale,	2	1908
Edward D. Drown,	Weldon,	½	1835
J. G. Steffin,	Norristown,	5	1800
Somerton Nurseries, A. U. Bannard, Mgr., 125 S. 5th St., Philadelphia,	Somerton,	20	1833
A. E. Wohlert,	Narberth,	10	....

MONROE COUNTY.

E. M. Werkeiser, Forest Plants and Seed- lings,	Stroudsburg,	Special.	
W. K. La Bar,	Mt. Pocono,	½	1846

NORTHAMPTON COUNTY.

Theodore Roth,	Nazareth,	½	1810
Hays Nursery Co.,	Easton,	1	1812
Easton Cemetery Co.,	Easton,	½	1811

NORTHUMBERLAND COUNTY.

*Francis W. Peifer, R. F. D.,	Fishers Ferry,	½	1836
S. L. Cummings,	Dewart,	½	1921

PERRY COUNTY.

Geo. A. Wagner, R. F. D.,	Landisburg,	4	1915
*Robert Kreitzer, R. D. No. 1,	Liverpool,	½	1840

PHILADELPHIA COUNTY.

W. W. Harper,	Chestnut Hill,	450	1744
Thos. Meehan & Sons, Inc.,	Germantown,	60	1756
T. N. Yates & Co.,	Mt. Airy,	6	1755
John B. Lewis,	Busleton,	5	1820
A. F. O'Connell, Overbrook,	Philadelphia,	65	1805
John Stephenson's Son,	Oak Lane,	3	1818
Phila. & Reading R. R. Co., Nursery at Wayne Junc.,	Philadelphia,	1	1830

*Grow berry or small fruit plants only.

POTTER COUNTY.

Perry Brigham,	Ulysses,	1	1878
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SNYDER COUNTY.

*T. G. Arbogast,	Swineford,	3	1883
*John F. Boyer, R. D. No. 4,	Middleburg,	5	1827
*Philip A. Apple, R. F. D.,	Middleburg,	1	1828
*Fred G. Moyer,	Freeburg,	1	1884
*A. W. Rohrer,	McKees Half Falls,	2	1882
F. L. Hancock,	Port Trevorton,	1	1829
*Moyer & Wilt,	Freeburg,	1	1885

SOMERSET COUNTY.

M. T. Lancaster,	Harnedsville,	1	1782
H. E. Purbough,	Harnedsville,	1	1779

SUSQUEHANNA COUNTY.

*E. A. Smith,	Heart Lake,	8	1857
*Geo. P. Sprout, R. D. No. 06,	Montrose,	6	1858

TIOGA COUNTY

Arthur Edwards,	Elkland,	1	1890
*Homer B. Howe,	Wellsboro,	2	1879
Penna. Department of Forestry, Paul H. Mulford, Forester,	Asaph,	14	1877

UNION COUNTY.

C. K. Sober, (Nursery near Paxinos, Northumberland Co.,)	Lewisburg,	18	1919
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VENANGO COUNTY.

Venango Nursery Co., R. F. R. No. 1, ..	Franklin,	2	1743
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WARREN COUNTY.

D. D. Hamblin,	Youngsville,	3	1770
*Geo. W. Wood,	Spring Creek,	1	1777

WESTMORELAND COUNTY.

John McAdams,	Mt. Pleasant,	1	1720
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WYOMING COUNTY.

*F. H. Fassett,	Meshoppen,	1	1788
*H. S. Hitchcock,	Laceyville,	1	1886
*W. E. Shoemaker,	Laceyville,	2	1887

YORK COUNTY.

Patterson Nursery Co.,	Stewartstown,	25	1917
Geo. E. Stein,	East Prospect,	7	1752
W. S. Newcomer,	Glenrock,	4	1753
E. J. Weiser, R. D. No. 7,	York,	1	1789
F. E. Cremer,	Hanover,	1	1757

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PENNSYLVANIA TREE DEALERS.

The tree dealer is defined as a person who purchases trees from different sources and sell them upon his own responsibility, not acting as an agent for any one nursery. He differs from an agent in the fact that the latter directly represents his firm and is selling upon a definite engagement, either on a salary basis or on a commission. Contracts made by an agent who is a representative of the firm, binds the firm, and therefore he is regarded as transacting business under the certificate or license which is held by his firm. This is why an agent is not required to have a certificate, while a tree dealer must have a certificate in order to transact business legally in Pennsylvania.

Any tree dealer can obtain a certificate by writing to this office, giving a list of the nurserymen from whom he expects to buy his stock. This may include one or more firms. They are then investigated by this office and if they be found properly certified and doing legitimate business in their own state or states, he is authorized to proceed with his plans, and is given a certificate permitting him to transact business in this State, buying from the firms named in his communication and in his certificate. This makes it illegal for him to buy from other firms, which may possibly not be doing legal business in their respective states.

The following is a list of the certified tree dealers in the State of Pennsylvania, revised to January 15, 1912.

AGENTS AND DEALERS FOR THE YEAR ENDING JULY 31, 1912.

Name.	Place.	No. of Certificate.
ALLEGHENY COUNTY.		
John W. Howard,	Pittsburgh, Pa., No. 7159 Mt. Vernon St., ..	573
John Bader Co.,	Pittsburgh, Pa.,	598
H. M. Devereaux,	Pittsburgh, Pa., No. 400 Homewood Ave., ..	561
W. B. Bockstose,	Castle Shannon, Pa.,	572
L. F. Miller,	Pittsburgh, Pa., No. 1023 Gerret St., ..	594
E. C. Hauser,	Bellevue, Pa.,	580
Charles Honess & Son,	Allegheny, Pa., No. 719 Fulton St.,	551
J. F. Zimmerman,	Pittsburgh, Pa.,	602
Mark E. Head,	Bellevue, Pa., No. 230 Rodgers Ave.,	550
Kauffman Bros.,	Pittsburgh, Pa.,	528
Jos. Horne Co.,	Pittsburgh, Pa.,	539
A. W. Graper,	Pittsburgh, Pa., No. 96 Diamond St.,	565
BEAVER COUNTY.		
J. C. Withrow,	Vanport, Pa.,	566
J. H. Gutermuth,	Rochester, Pa.,	583
A. E. Crouch,	Rochester, Pa.,	548
BEDFORD COUNTY.		
Elijah Collins,	Clearville, Pa.,	564
W. D. Slick,	New Paris, Pa.,	591

Name.	Place.	No. of Certificate.
BERKS COUNTY.		
L. M. Neischwender,	Hamburg, Pa., R. D. No. 4,	574
M. E. Smeltzer,	Reading, Pa., No. 131 W. Greenwich St., ..	537
Alfred Dreibelis,	Reading, Pa.,	541
W. H. McKinney,	Sinking Springs, Pa., R. D. No. 1,	542
BLAIR COUNTY.		
E. J. & A. A. Whitbred, ..	Altoona, Pa.,	618
BRADFORD COUNTY.		
J. F. Gable,	Athens, Pa.,	608
BUCKS COUNTY		
John F. Barclay,	Doylestown, Pa., R. D. No. 2,	592
BUTLER COUNTY.		
W. C. Riddle,	Slippery Rock, Pa.,	582
Geo. W. Haine,	Evans City, Pa.,	554
CARBON COUNTY.		
Paul Neihoff,	Lehighton, Pa.,	575
David N. Rehr,	Lehighton, Pa.,	610
CHESTER COUNTY.		
John Alcorn,	Malvern, Pa.,	601
CLEARFIELD COUNTY.		
Thos. W. Munro,	Du Bois, Pa.,	558
CLINTON COUNTY.		
W. W. Richie,	Lock Haven, Pa.,	596
CRAWFORD COUNTY.		
J. A. Knapp,	Meadville, Pa.,	616
B. D. Maynard,	Saegerstown, Pa.,	611
J. C. Boyd,	Guy's Mills, Pa.,	577
A. B. Greenfield & Sons, ...	Conneautville, Pa.,	537
J. B. Long,	Harmonsburg, Pa.,	614
E. A. Beebe,	Conneautville, Pa.,	586
CUMBERLAND COUNTY.		
Ira E. Bigler,	Camp Hill, Pa.,	578
D. C. Rupp,	Shiremanstown, Pa.,	534
Towzer & Son,	Carlisle, Pa.,	547
DAUPHIN COUNTY.		
A. H. Shreiner,	Harrisburg, Pa., No. 813 N. 16th St.,	590
Geo. F. Greenawalt,	Hummelstown, Pa.,	533
T. A. Woods,	Harrisburg, Pa.,	
J. R. Snavelly,	Harrisburg, Pa., No. 125 Liberty St.,	615
Holmes Seed Co.,	Harrisburg, Pa.,	613
DELAWARE COUNTY.		
John Wetherill,	Chester, Pa.,	605
ERIE COUNTY.		
Wm. Keefe & Son,	Erie, Pa., No. 708 French St.,	531
C. J. Roberts,	Albion, Pa.,	581
H. C. Pettis,	Platea, Pa.,	584
C. F. Amidou,	North East,	595

Place.	No. of Certificate.
FRANKLIN COUNTY.	
H. C. Ely, .....Waynesboro, Pa.,	579
J. W. Heffelfinger, .....Greenville, Pa.,	555
W. E. Nisewander, .....Mason and Dixon, Pa.,	540
FULTON COUNTY.	
Geo. W. Sipe, .....Harrisonville, Pa.,	580
LACKAWANNA COUNTY.	
G. R. Clark, .....Scranton, Pa., No. 124 Washington Ave.,...	567
Giles L. Clark, .....Scranton, Pa., No. 900 Wood St.,	612
A. J. Noble, .....Scranton, Pa., No. 723 Columbia Ave., ..	600
LANCASTER COUNTY.	
Amos D. Herr, .....Lancaster, Pa., No. 510 W. Orange St.,	576
Daniel G. Engle, .....Marietta, Pa.,	569
LEBANON COUNTY.	
Samuel P. Moyer, .....Myerstown, Pa.,	568
M. D. M. Batdorf, .....Richland, Pa.,	527
LEHIGH COUNTY.	
Melchoir Werkheiser, .....Allentown, Pa.,	608
Samuel I. Leh, .....Allentown, Pa.,	529
LUZERNE COUNTY.	
Bonsey & Rifkin, .....Wilkes-Barre, Pa.,	532
F. B. Wheeler, .....Wyoming,	598
J. D. Anderson, .....Laketon, Pa.,	609
LYCOMING COUNTY.	
Evenden Bros., .....Williamsport, Pa.,	607
McKEAN COUNTY.	
F. S. Palmer, .....Bradford, Pa.,	557
MONROE COUNTY.	
L. D. Eilenberger, .....E. Stroudsburg, Pa.,	587
S. P. Smiley, .....Stroudsburg, No. 810 Scott St.,	556
MONTGOMERY COUNTY.	
Geo. Shoettle, .....Norristown, Pa.,	559
NORTHAMPTON COUNTY.	
Dominico Sebastino, .....Roseto, Pa.,	588
Herbert Inman, .....Easton, Pa.,	597
NORTHUMBERLAND COUNTY.	
H. F. Frank, .....Montandon, Pa.,	545
L. W. Foust, .....Watsonstown, Pa.,	571

Name.	Place.	No. of Certificate.
PHILADELPHIA COUNTY.		
Moore Seed Co.,	Philadelphia, Pa.,	552
J. R. Giffen,	Philadelphia, Pa., No. 5341 Webster St., ...	535
Wm. Henry Maule,	Philadelphia, Pa.,	530
Henry F. Michel Co.,	Philadelphia, Pa.,	544
Johnson Seed Co.,	Philadelphia, Pa., No. 217 Market St.,	526
Hosea Waterer,	Philadelphia, Pa., No. 107 S. 7th St.,	604
Lit Bros.,	Philadelphia, Pa.,	606
SCHUYLKILL COUNTY.		
W. O. Snyder,	Minersville, Pa.,	590
TIOGA COUNTY.		
E. H. Wheaton,	Knoxville, Pa.,	540
Arthur Edwards,	Elkland, Pa.,	617
UNION COUNTY.		
J. G. Oberdorf,	Mifflinburg, Pa., R. D. No. 2,	570
VENANGO COUNTY.		
John F.	Franklin, Pa.,	568
WYOMING COUNTY.		
W. A.	Eatonville, Pa.,	553
YORK COUNTY.		
C. H. Snyder,	York, Pa., No. 1101 W. Poplar St.,	543
J. H. Painter,	York, Pa., No. 235 E. Prospect St.,	585
Henry Everhart,	Manchester, Pa.,	589
D. C. Kauffman,	York, Pa., No. 18 W. Philadelphia, St., ...	549
OHIO.		
Jones & Vernon,	Troy, Miami Co., Ohio,	563
Myers Bros. & Co.,	Wilmot, Stark Co., Ohio,	562

THE BI-MONTHLY ZOOLOGICAL BULLETIN

OF THE

DIVISION OF ZOOLOGY

OF THE

PENNSYLVANIA DEPARTMENT OF AGRICULTURE



VOL. II.—No. 2

SUBJECT: { How to Avoid Culls.
Grafting and Budding.
Spraying Apparatus.

MARCH 1912.

H. A. SURFACE, D. Sci., Economic Zoologist,
Editor

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1912

THE BI-MONTHLY ZOOLOGICAL BULLETIN OF THE DIVI-
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VOL. II, No. 2.

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REMARKS BY THE ECONOMIC ZOOLOGIST.

These Bulletins are free, but are sent only to persons who request them. We have a regular mailing list which is maintained without change until it grows to such an extent that it is necessary to revise it. This is generally about once every two or three years. Full notice is then given in the Bulletins to the effect that the list is to be revised, and all names will be retained of persons who desire the Bulletins in the future. If your neighbor or acquaintance is interested in any subjects pertaining to the work of this office and treated in the Bulletin, ask him to send us a postal card giving his name and address for this free mailing list, or you may send his name and address and at the same time notify him that you have done so. If he is not so notified he may also send his name, and this will result in duplication and unnecessary expense.

Why not use these Bulletins in your schools? Some of them furnish the basis for manual training lessons, nature study, and literature for reading, as well as the elements of horticulture, agriculture, entomology, ornithology, general zoölogy, etc. In some of the most progressive schools of America, such as the city of Chicago, these Bulletins are used regularly among the teachers. In the State of Pennsylvania we will send regularly to any teacher enough Bulletins of each issue to supply each member in his class with one for reading purposes. All that is necessary is to let us know how many are wanted, and they will be furnished free.

The State can do nothing that will result in more good than training young folks to think and act along the lines of practical and scientific subjects. Your co-operation in such an educational campaign is enlisted. Officers of organizations such as local granges, alliances, farmers' clubs, horticultural societies, civic clubs, or any other organization may arrange to receive enough copies of each issue of the Bulletin to be distributed at the meeting of the club, by sending us a statement of the desired number to be recorded on our permanent list. However, Bulletins will reach readers more regularly and promptly by each having his own name on our mailing list, and thus have the Bulletin sent directly to him. When a change of address is to be made care should be taken to notify us promptly, GIVING THE NAME OF THE FORMER AS WELL AS THE NEW POST OFFICE. Various subjects are treated in different Bulletins,

and persons who wish back numbers on any particular topic within the realm of this office can obtain them by writing for them.

Address all communications and specimens to

H. A. SURFACE,
Economic Zoologist,
Harrisburg, Pa.

OUR CHAT WITH READERS.

1. **Bulletin Wanted:** We find upon attempting to make up complete sets of the Bulletins issued by this office, that we particularly need several copies of the April and May issue, 1910, combined Numbers 11 and 12, of Volume VII, of the Monthly Bulletins. We shall appreciate it if any person can mail to us one or more copies of this issue. Any literature at our command will be gladly sent in quantity in exchange.

2. **Avoid Nostrums and Expensive Materials:** Fruit growers have the common experience that as soon as their names and addresses are published, they are assailed with a flood of circulars advertising all kinds of wares and materials. We take this occasion to issue a warning against the indiscriminate use of nostrums or supplies of any kind or brand that are not known to be absolutely safe to use and reasonably economical. Almost all insecticides and fungicides can be made in the orchard cheaper than they can be purchased, and the quality of the home-made article is such as to bring good results. Before buying supplies it is best to write to this office for information concerning any brand or firm. This is given promptly and impartially.

3. **Get Good Spraying Apparatus.** It pays to equip ones self with good apparatus. This saves time and does better work, and gives far greater returns. Use long hose, good extension rod, shut-off, bend for nozzles, and other modern equipment.

4. **Take Care of Apparatus.** It pays well to take good care of spraying apparatus. Each day after using it run clear water through it, and remove, wash and oil the nozzles. Be sure that strainers are not left for sediment to dry in them. Before putting apparatus away, wash the tanks or barrels and leave clean water in the wooden vessels to prevent their drying and shrinking.

5. **Attend the Orchard Demonstrations.** This spring, in each county, Orchard Demonstrations will be given. They are announced

in the local press, and in each case the Demonstrator will be there on time regardless of weather. This carries practical, modern instruction to your door. No one can afford to miss it. Take specimens for inspection, ask questions, and see the work of pruning and spraying properly done. Write to this office for such help as can be given by correspondence.

Address,

H. A. SURFACE,
Economic Zoologist,
Harrisburg, Pa.

HOW TO AVOID CULLS.

The greatest source of loss for the fruit grower is in the production of culls. That man is most successful as a producer who is able to reduce the percentage of culls to the lowest extent. In many orchards heretofore the quality of the fruit has been such that it should really all be graded as "seconds" or "culls." Any person can grow a few large and well colored fruits in the top of the tree, but it requires horticultural art to grow fruits of uniform size and color in abundance throughout the entire tree top. A poorly grown or imperfect fruit exhausts the vitality of the tree as much as does one that is perfect, as it is the production of seed, and not the production of fruit pulp, which exhausts the energy of the tree. To produce a bushel of small seconds, such as are ordinarily seen in too many farm orchards, draws upon the vitality or vital resources of the tree much more than to produce a bushel of good, large, fine fruits, for the reason that there are many more seeds in the former than in the latter.

Fancy fruits are always in demand. They find ready sale at good prices. The poorer they are in quality or appearance the lower the price. Where but ten per cent. of the fruit of the tree or orchard is good, even though they may sell at a high price, the rest must be sold at such a low price (if it can be sold at all) that there is no profit in growing any of it. Where a tree is properly cared for, pruned, sprayed and fed, and the fruit thinned, this fruit will be much larger and more uniform in size, and more surely an annual crop, than where it is allowed to grow in a more or less neglected manner crowded upon the tree. Considering only the reduced in-

jurious effects upon the vigor of the tree, it can really be said that it costs no more to grow good fruits than to grow culls, and the income in both pleasure and profits is far greater.

The inspiration which comes to the grower in producing a fancy article, realizing that he has put his knowledge to the practical test, and has produced satisfactory results, is one of the greatest sources of pleasure to the fruit grower. He who grows fancy fruits is proud of his achievements, as, indeed, he has cause to be. He who grows poor fruits may well feel that he has failed to apply the principles of advanced horticulture in his art of fruit production, and thus fails to obtain that inspiration and impetus which impels him to go forward in his work inspired with a love of his business enterprise and its results.

Many persons are growing culls or low grade fruits because they do not know just what constitutes a high grade product; nor do they know how to obtain such results from their own efforts. Therefore, it is fitting to say that *fruit of the right kind should be free from injury by insects and plant diseases, of fair size, of good color, and of uniform size upon the same tree and in the same orchard, and free from bruises or other artificial injury.* A defect in any one of these features renders the fruit inferior, and, consequently, less valuable. It is our purpose to show how such defects can be avoided.

In brief, only by the practice of proper horticultural methods and care is it possible to produce first class results. Were we to tell a man what to do to avoid culls, we should say, "prune, spray, fertilize, cultivate, thin the fruit, and handle all fruit properly in picking, packing and shipping." We have Bulletins for free distribution containing articles of greater or less length touching upon these various topics, and it now remains to tell how to obtain certain results which bear directly upon the elements of quality.

1. How to Grow Fruit Free From Insect Injury.

There is really no excuse for growing much insect-damaged fruit in this State. It has not been uncommon to see marks of San José scale and other scale insects on fruits in market, and even in exhibitions. The little blotches where the scale insect has poisoned the fruit and caused the red strain around it are very conspicuous and easily recognized. The Curculio punctures the fruit and makes it wormy or knotty, while the Codling moth feeds within it and bores a hole through the fruit (generally at the blossom end, but sometimes at the side) as it passes out. The only means of preventing damage by insects is to apply the right insecticide, in the right manner, at the right time, and also by the right kind of apparatus. Each

pest is likely to demand special treatment for its own kind in regard to the kind and strength of material to use, and the date and method of application.

San José Scale and Other Scale Insects. For the San José scale and other scale insects spray with the boiled lime-sulfur solution, either homemade or commercial, before the blossoms open. Dilute the commercial lime-sulfur solution with about eight times its bulk of water, or make your own lime-sulfur solution in a very efficient and economical manner by boiling together for one hour, one pound of quick lime, two pounds of powdered sulfur and one gallon of water. After letting this stand and settle, the red liquid can be drawn off and stored as concentrated lime-sulfur solution, and is chemically exactly the same as the commercial material. It can be used as a winter spray, when trees or bushes are dormant, by diluting it with about seven or eight times its bulk of water, which need not be heated; or, it can be used as a summer spray by diluting it for apple, pear and quince with about forty times its bulk of water, and for peach using one gallon of the solution in one hundred and fifty gallons of water.

As an insecticide it kills the scale insects with which it comes in contact during the dormant season, and it does not injure any kind of dormant tree, shrub or bush to which it is applied at any strength as a wash or a spray. It also destroys the eggs of the Canker worm, the Tent caterpillar, Plant lice and other pests, and kills the Peach twig borer and other insects with which it may come in contact. It is the only material that we recommend as a preparation for uniformly spraying all trees and bushes when dormant. It is best to dilute it by the hydrometer test, following the directions which are sent free from this office for this purpose.

The Codling Moth. The most important insect enemy of the apple, pear and quince is the Codling moth. This is the one that makes the wormy fruit. Its ravages are too familiar to all. Our Demonstration Work has shown clearly that it is possible, without difficulty, to reduce the damage by this pest to two per cent. of the fruit on trees. This has been observed in several Demonstration Orchards throughout the State, such as that of Mr. D. S. Kloss, at Tyrone, Pa.; the Huntingdon Reformatory, at Huntingdon, Pa.; the orchard of the Norristown Asylum, at Norristown, Pa.; the Berks County Almshouse; and others examined by the writer when many fruit growers and visitors were present.

The best treatment for the Codling moth is to spray just after the blossoms fall, and again in about a month, with two pounds of arsenate of lead in each fifty gallons of liquid. For the Codling moth alone, the liquid may be nothing but water, but it is better to make

the dilute lime-sulfur solution by using one gallon and one quart of the concentrated material in fifty gallons of water, and to this add the two pounds of arsenate of lead. In this formula we refer to the arsenate of lead in paste or liquid form. Where the dry powdered arsenate of lead is used, only one-half as much will be required as of the paste form.

In spraying for the Codling moth considerable power should be used, and the spray should be applied with a turn on the end of the extension rod to direct the nozzle in such a manner as to throw the liquid well into the calyx end of the fruit. This should be done before the little green points commence to close together. In most cases the nozzle should be held above the fruit and the spray directed downward over it. The second application should be made in about one month. It is not necessary to worry about bands or sticky applications, traps, etc., for the Codling moth if the spraying be done with the material of proper strength, and at the right time. Never *spray when in bloom.*

The Curculio. The Curculio is the little brown beetle about the size of a small pea which feeds on the fruit and foliage of many fruit trees in the early spring and summer, and lays its eggs in the fruits. It lives in the form of a larva or worm in the little fallen apples, and is also the cause of worminess in peaches, plums and cherries. The feeding punctures are recognized as crescents or moon-shaped marks in the skin of the fruit, while egg punctures are made manifest in the form of small holes in the same. The Curculio larva does not develop in the apples and pears that remain upon the tree, but it does live in those which fall on the ground. The fruit that has been stung by it, but which remains upon the tree, becomes very knotty and is, of course, decidedly inferior.

It has been believed until very recently that the best remedy for the Curculio was to jar the trees over a cloth or net to act as a "curculio catcher." This has been very effective, but so tedious as to be quite expensive. Now thorough spraying with arsenate of lead takes the place of jarring. Spray just after the blossoms fall, and spray peach and plum again just after the little brown husks or "collars" fall from the young fruit. Then repeat the spraying about once every three weeks. Spray apples and pears once or twice after the second spraying for the Codling moth, but as the first and second sprayings for this moth is the time appropriate for the spraying for the Curculio there is no need of additional applications at that time for the last-named insect. It should be remembered that the arsenate of lead can be used at the strength of from two to three pounds of the lead paste in fifty gallons of liquid, the "liquid," in order to act as a fungicide as well as insecticide, should be dilute lime-sulfur

solution of Bordeaux mixture, with the preference for the former. For the stone fruits the lime-sulfur solution should be diluted by using only one gallon in one hundred and fifty gallons of water, but to each fifty gallons of this the two pounds of arsenate of lead can be added, just the same as the two pounds in fifty gallons slightly stronger for the apple, pear and quince.

Other insects that are liable to injure the fruit should be treated according to methods recommended for each respectively, and as information concerning means of suppressing them can be obtained free from the office of the Economic Zoologist, at Harrisburg, it is not necessary to fill this Bulletin with the repeated discussion of methods of treating them.

2. How to Avoid Blemishes by Disease Marks.

In the northern part of Pennsylvania there is a pest of the apple, pear and quince that is very serious, and which demands attention in every treatise on the production of perfect fruit. This is the Pear-leaf blister mite. It is not exactly an insect, as it is more nearly a spider. It is not a disease, but it is an enemy, one of the evil effects of which is a blotching of the surface of the fruit. Fortunately, it is easily suppressed by spraying during the dormant season with the full strength lime-sulfur solution, the same as for San José scale. This is because the mite winters under the scales of the buds, and is to be treated by applications when dormant.

Nearly all fungous diseases of fruits are to be prevented by spraying with a fungicide, which is a material that will destroy the germs of the diseases before they enter the fruit or leaf and damage the tissues of the plant. The chief fungicides in use are (1) the Bordeaux mixture, made by using about three pounds of fresh lime and three pounds of blue stone in fifty gallons of water; and (2) dilute lime-sulfur solution, made as directed above, by diluting either the home-boiled or commercial article, and (3) the self-boiled lime-sulfur solution, made by heating together eight pounds of lime and eight pounds of sulfur by the slaking of the lime for ten minutes, then cooling to fifty gallons of water.

In applying fungicides it should be remembered that the leaves of the stone fruits are more delicate than those of pome fruits, or apple, pear and quince, and, therefore, the liquid should be applied more dilute on the foliage of peach than upon that of apple. This is one of the important objections against planting peaches as fillers in apple orchards.

If the spraying with a fungicide is to be done at the same time as some of the applications of insecticides, it is economy in saving time and labor to mix the insecticide (such as arsenate of lead) in a

fungicide instead of in water. Thus the best mixture to be recommended for an apple orchard is two pounds of arsenate of lead in fifty gallons of dilute lime-sulfur solution, made by using one gallon and one quart of the strong lime-sulfur in about forty-nine gallons of water.

The first application of the fungicide should be made shortly after the buds burst, or before the blossoms open. The next should be made just after the blossoms fall, and is the time for the first spraying for the Codling moth and Curculio; and during the summer it should be applied about once every three or four weeks, until after midsummer, or the time when the fruits are nearly full grown, but it is, as a rule, not necessary to apply the fungicide after this period. However, if heavy rainfall washes the material from the leaves or fruit, a second application should be made as soon as possible. During the growing season it should be applied more frequently than after the growing season has passed.

The operator should keep in mind that the chief point in using a fungicide is to keep the surface of the fruit and leaf well covered with it, in order that disease germs which may fall thereon may be destroyed when they first commence to develop, and before they have had opportunity to enter the leaf or fruit. Thus a thorough coating of this material present all the time is the best possible means of preventing damage from fungous diseases. However, it should be remembered that some diseases, such as Apple scab, Bitter rot and Cedar rust, do not respond as readily to treatment, especially with certain materials, as do others. For example, the Bordeaux mixture should be used for the diseases just named, instead of using the lime-sulfur solution, while the self-boiled lime-sulfur solution is probably best as a preventive of Ripe Rot of plum and peach.

Some diseases are to be treated by other means than spraying; as, for example, in preventing damage by the Cedar rust which makes orange colored spots in the fruit and leaf, the best thing to do is to destroy the cedar trees within a radius of two hundred yards of the places where apples, pears and quinces are grown. Certain other diseases are not susceptible to check by the spray pump. Among these are such as the Pear blight, Peach yellows, etc.

There are several diseases of plants that are not directly of a fungoid nature, or due to fungous germs. Some are bacterial, such as Fire blight, Pear blight, Black blight, or Bark blight, as it is variously called. The Black-rotting of cabbage is an example of a bacterial rather than of a fungous disease. Other diseases are uncertain in origin, but they may be very decided in their effects. Among these are the Peach yellows, Little peaches, Peach rosette, etc. Spraying does no good for these diseases. The best treatment

is to tear out the trees infected with them. For the blight cut out the blighted parts at least one foot below the point of infection and burn them, being careful to avoid carrying the disease from one part of the orchard to another, or from one tree to another by means of germs on the pruning knife or saw. To avoid this wipe it with a cloth dipped in dilute formalin solution.

Spraying alone is not sufficient to insure perfection of fruit from disease marks. The tree should be grown on soil that is not too wet, and in a location where there is plenty of air drainage; it should be pruned in such a way that there will be sufficient ventilation and sunshine in its top. There is one disease particularly known as "Fly speck fungus and Sooty blotch," which blotches fruits as though they were covered or marked with soot in spots. This discoloration to fruit prevents it from being marked as strictly fancy. It occurs mostly on fruits that are grown where there is not sufficient ventilation and penetration by pure air and sunshine. A well pruned, open-headed tree is greater proof against sooty blotch than is a tree that was merely sprayed but not properly pruned.

3. How to Grow Fruits of Uniform Size.

This is something of considerable importance for each fruit grower.

The art of grading is quite an accomplishment, but it is a greater accomplishment to grow fruits that do not need to be graded. The importance of uniformity of size is seen when we remember that in every fancy package of fruit, there should be one size only. In packing in modern small packages, like the bushel box for apples, it is impossible to properly pack fruits that are not graded to just one size. When large and small fruits are sold in the same package one destroys the appearance and selling value of the other. If a person should grow large and small fruits of the same kind, it will pay him well to grade them in size, even though he should sell the fruits of different sizes all as first quality, each of its own respective size. There are persons who wish the large fruits, but, fortunately, many more who prefer them of medium size. It is well that the tendency of the times is toward the well grown fruit of medium size, and away from the gigantic fruits that are sometimes produced on young or vigorous trees, and which do not fairly represent the type of their variety.

To grow fruits of fair and uniform size it is necessary to prune the trees well, so as to insure a fairly vigorous, or at least uniform growth throughout the top. It can be laid down as a fundamental principle that whatever increases the vigor or growth of the leaf will

also increase the vigor or growth and size of the fruit. Thus, pruning when dormant is one of the first steps toward increasing the growth, and, consequently, the size of the fruit.

The next step in this regard is to feed the tree. Fertilization is essential. We can not expect to continue to produce fruit without putting back in the soil the material that must be taken by the roots to supply the essential needs in building fruit. A tree growing on poor soil, or on a dry hillside will produce small fruits, while those of another of the same kind in fertile soil, or where it is damp, will be of much larger size.

The elements of fertility really needed are, as a rule, those contained in a "complete fertilizer," and should comprise the ingredients commonly known as nitrogen, phosphoric acid and potash. However, it can justly be said that no man should be obliged to buy nitrogen for fruit production. He should get his land in shape to grow his own. This is grown chiefly by the use of the clovers or other legume plants, such as soja beans, field peas, cow peas, vetch, etc. It may be necessary to purchase phosphoric acid and potash, but it is an easy thing for a man to apply some of each to his soil, and thus make a test and find out what his trees need. This is a practical way to question the trees and obtain their answer. Whatever will increase the vigor of the trees, showing in the size and healthfulness of the leaf and fruit, is an advantage; and this should be employed. In fact, a well fertilized tree is one that is well fortified against injury by insect pests and most plant diseases, in comparison with one that is half starved.

Just as a physician looks after the feeding and other care of his patient, as well as attempting to cure his assailing ills, so must a horticulturist maintain the vigor of his trees in every possible way. At the same time, just as a patient may suffer from overfeeding, so can a tree be injured by the addition of too much fertilizer and too much attention. For example, too much nitrogen fertilizer pushes the growth of leaf and wood, and makes fruit of too large size, dull or green in color, and poorer in keeping quality than those which are grown with less vigor. Too much water in the soil, too much cultivation, continued late cultivation, and too much nitrogen fertilizer all are evils that should be watched and corrected, remembering that the horticulturist should have a knowledge of what is enough and know how to get it in the most effective and economic manner and at the right time, as well as what is too much and how to avoid it.

Among the nitrogen fertilizers that are used with good effect is such as stable manure or barnyard manure, which can well be applied to any orchard at any time, provided the woody growth is not too rank.

To grow fruits of good size, and also of uniform size, water at the right time is essential. This is best applied by means of cultivation, to retain it in the soil for the time when the trees need it. Thus in a well cultivated orchard you are much more liable to produce fruits of large and uniform size, than in one that is not cared for in this regard. The cultivation should be from early spring until mid-summer, and should be sufficiently frequent to retain, for the use of the trees for the summer and fall, the moisture which fell as snow or rain during the winter and spring.

To produce fruits of uniform size, and also of large size, it is absolutely necessary that thinning be practiced. The man who permits his trees to attempt to bear all the fruits that remain or "set" upon them, is doing himself a great injustice. Modern horticulture demands a considerable amount of thinning. In our own practice we have pulled hundreds of bushels of peaches from our trees immediately after the June drop, and have been well rewarded by the crop being fully as large and fruits much larger in size than would have been produced had it not been for the practice of thinning. As explained above, these fruits, because reduced in numbers on the same tree, have not been as exhaustive on the trees as they would have been had thinning not been practiced, and thus the trees were able to bear fruit and set fruit buds during the same year—preparing for the next year's crop. It is thus seen that thinning, in addition to insuring a uniformity of size of fruits, and getting rid of those that are damaged by insects, fungous diseases or other means, also preserves the vigor of the trees, equally distributes their load, aids in preventing breaking, and makes it much more liable to bear every year, instead of falling into the old routine of "every-other-year bearing." This "off" and "full crop" year condition is caused by the bearing of an extra full crop, which is really over-bearing, with fruits of various sizes and broken branches, but demanding a rest or "off year" to follow.

It is not for us to discuss now the methods of thinning, but it is enough to say that all kinds of fruits should be thinned, and indeed, should be thinned much more than most persons believe. The best means of doing this is by hand; and although at first it may appear tedious, it really will save considerable time and expense. The same fruits, after remaining on the trees, must be picked by fall. If the trees are properly thinned the remaining fruits become much larger than they would otherwise, and far more remain on the trees until picking season than would have remained had the trees not been thinned. Because of the large and uniform size they yield much greater returns in money.

The time taken to pull the little fruits from the trees and throw them upon the ground is not nearly as long as would have been required to pick them as mature fruits and place them in vessels to be carried away. Thus thinning can be done more quickly than picking, and consequently at a saving of time and money. When this is considered, together with the benefits of the production of fruits of uniform size, and the lessened drain upon the vitality of the tree, and the aid toward a crop each year, it can be seen that it will pay our orchardists to practice the art of thinning much more extensively than they have done in the past. It will pay to thin all kinds of fruit without exception; and the person who wishes to grow the very largest and finest fruits and obtain the fancy top prices for the best grown fruit, is the one who will give attention to the comparatively new art of thinning, as well as to pruning, spraying, fertilizing, cultivating his trees, and properly handling his fruit.

4. How to Grow Fruits of Uniform Color.

The color of fruit is one of the most important attractive features for its sale. Why do customers prefer highly colored fruits? It is chiefly because of the fact that a well colored specimen of any variety has been better grown and has better flavor than a poorly colored specimen of the same variety. This does not mean that a red apple has better quality than a yellow apple. It is unfortunate that the buying public demands, generally, red fruit, while some of the very best, such as the Greenings, Grimes Golden, and the Pippins are entirely without this color. It is no doubt true that in the future consumers will become educated to buying according to variety rather than mere appearance. Then the apples and other fruits which naturally do not become red in their process of ripening will have an equal showing with those varieties that are more highly colored, by standing on their own intrinsic merits. In all cases, however, it is best for the grower to produce fruits of just as good color as possible, and the production of fruits that are uniformly colored is an art which must be the outcome of the skillful application of knowledge. It should be explained that by "uniform color" we do not mean that any particular apple should be a solid color of one kind, but we do mean that all apples grown on one tree should contain practically the same amount of the color that belongs to that variety when well grown. It really makes no difference how perfect the fruit, nor how uniform in size, if it is not uniform in color it cannot be marketed as strictly fancy fruit. The eastern growers should know that in the West, where grading has reached its highest perfection, fruits are graded down for lack of sufficient amount of coloration

just as surely as they are graded into lower classes for injury by diseases, insects, or bruises; and they are also placed in different grades according to size.

In growing fruits of high color one of the important desiderata is land elevation and proper soil. It is probably true that iron in the soil is as necessary for producing the red color of an apple or peach as it is for producing the red tint in our own blood. Yet practically all soil contains enough iron to give full coloration to fruits if the other features of orchard management are correct. In other words, it is scarcely necessary to take the trouble to scatter iron filings, tin cans, etc., around trees for the sake of giving the soil iron enough to produce more highly colored fruits. In fact, we have record of where this has been done to the detriment rather than to the benefit of the trees.

Good fruit soil, containing some iron, and well grown, healthy, properly pruned, open-headed trees, are the first factors in giving color to fruits. Pruning is an element that contributes greatly toward color. Where a tree is grown by the tall, central shaft system, like the central stem of a pine tree, its branches close together as they sink downward by the weight of the fruit and the result then is to produce highly colored fruits on the outside where the sunshine falls upon them, and poorly colored fruits on the inside. On the other hand, a tree that is grown by the open-head system, which is exactly the reverse of the central stem system, is so open that as its branches become laden with fruit and droop away from the open center, the sunshine enters and falls upon most of the fruit on the tree and colors it much more uniformly.

It should be remembered that whatever tends to produce a vigorous growth of leaf or fruit is unfavorable to high coloration; therefore, nitrogen fertilizer, in the form of Nitrate of Soda or manure, late cultivation, late irrigation, and strong dormant pruning—all of which tend to push more vigorous growth—are unfavorable to the production of highly colored fruits. Thus fruits which are produced on trees that have been fertilized with Phosphoric Acid and Potash, with the nitrogen reduced, and which have been grown by the sod mulch system or some other system that has not resulted in rankest growth, and which have been only moderately pruned during the winter, and also pruned to some extent during the summer, are, as a rule, the best in color.

To obtain fruits of uniform color it is necessary to have it properly thinned and have the trees so pruned that there will be no dense places where the light, air and heat cannot readily enter. Light summer pruning not only helps in producing fruits of good color, but is also an advantage, if done at the right time, in setting fruit buds for the next year's crop.

There is a generally prevalent idea that spraying is the panacea for all the ills of the horticulturist and is the chief factor in producing fruits of large size and high color. As a matter of fact, spraying tends to produce fruits of lower color rather than higher, for the reason that it increases the vigor and vitality of the tree and thus brings it under the general rule of "Whatever stimulates growth tends to reduce high coloration." However, it is also known that spraying keeps the fruit longer on the trees, and thus gives time for greater development of color, and by the close of the later picking period the sprayed fruits, picked late, will have developed fully as much color as the unsprayed fruits which have dropped or have been picked early. It is also often thought that spraying will produce larger fruits. This is a mistake, as size is not due to spraying, so much as it is due to properly pruning, feeding and watering or cultivating the tree.

5. *How to Avoid Wind Falls and Early Dropping.*

The greatest objection to certain fruits of very high quality, such as the Baldwin, is that they drop early. It is not generally known that this evil can be corrected by a proper modern horticultural practice. It can again be stated that it is a general rule that *whatever factors tend to increase the vigor of the tree hold both the foliage and the fruits later in the fall*. Every person has noticed how some trees retain their green leaves until very late in the fall, while others drop their leaves early. It is the vigorous trees which retain their foliage, and those which for any reason are enfeebled drop them sooner. The same is true of the fruits. On vigorous trees we see the late-hanging fruits, while from a sickly tree of the same kind we find the fruits dropping early. Spraying increases the healthfulness of the trees, and especially of the leaves and fruit. Consequently spraying results, not only in perfect fruit in regard to freedom from fungous diseases and insects, but also in fruits that stay later on the tree. In this connection it should also be mentioned that sprayed fruits keep longer in storage or in the cellar or bin than those that are unsprayed. It is because the application of the fungicide destroyed the disease germs which would have started decay sooner. We have observed this in all fruits, and have had it reported to us several times, but a striking example, worthy of note, is seen in the experience of Mr. W. H. Banzhaf, of Muncy, Pa., who is the recently elected president of the Lycoming County Horticultural Association. He reported to us recently that his apples, kept in an ordinary cellar in barrels, were keeping remarkably well on the first of March. In sorting three barrels he found only twelve specked apples, while at the same date his neighbors, who did not spray, were finding one half

of their apples, of the same varieties, in a more or less decayed condition.

Other factors which contribute to keeping fruit late on the tree are, (1) planting on northern exposure, (2) severe dormant pruning, (3) cultivating, and (4) stimulating growth by nitrogen fertilizer. It is true that the same variety of tree, growing on a northern slope, ripens its fruit later than one growing on a southern slope, but in many cases, as for example, bearing Baldwin trees, the direction of the slope cannot be altered, and the question arises as to how to keep the fruit later on such trees.

Cultivation certainly has its place in retaining the fruit. It is one of the factors that increases the vigor of the tree. Late cultivation particularly has this effect. Apple trees are not nearly as subject to injury by freezing following late cultivation as are peach trees, consequently, this can be practiced for the apple with good results.

Nitrogen fertilizer, especially such as Nitrate of Soda, which stimulates vigorous growth, certainly aids in retaining both foliage and fruit, and consequently the application of Nitrate of Soda in the summer is one of the means of helping to retain on the trees those fruits that would fall early. Other forms of nitrogen fertilizer than Nitrate of Soda applied earlier, would have the same results, but the most quickly acting plant stimulant in regard to growth is this Nitrate which can, therefore, be applied later in the season than can the other forms, when applied for the purpose of retaining the fruit on the tree.

Dormant pruning is another factor that stimulates the growth of the fruit and consequently keeps it later, but it is not advisable to overdo this practice. It is certain that fruit can be held late on the trees by late cultivation, the application of nitrogen fertilizer, and thorough spraying with a fungicide. Where these can be combined with dormant pruning and a northern exposure one has all the factors that will be needed, and perhaps all that are possible, to contribute toward this object.

6. How to Avoid Bruise Marks on Fruits.

It makes no difference how well fruits are grown, how large in size, how high their color, nor how perfect they may be in freedom from injury by insects or disease, if they are bruised they can not be packed and sold in the grade known as "fancy," but must be rated as "seconds" or "culls" depending upon the amount of bruises.

Fruit growers must study how to gather their fruits without injury, and how to put them on the market in a careful and perfect manner. To facilitate this certain conditions must be in their favor. For example, it is impossible to climb a long extension ladder to a

three-story old-fashioned tree, and pick fruits in a bag, as by the old method, climb down the ladder, pour the fruit on the ground, sort the same, grade it, re-pile it, and pack it into barrels, without considerable damage in the process of handling.

In the first place, the tall tree should be eliminated by proper pruning, if not by the axe. One need not hesitate about lowering the tops of his tall trees. We have seen this done again and again. For example, it is well known that the Winter Sweet Paradise apple becomes very tall, and under ordinary circumstances bears its fruit only toward the top. In our Demonstration Orchard of Mr. D. S. Kloss, of Tyrone, last fall we saw the most magnificent specimens of Winter Sweet Paradise on low branches, that were actually touching the ground. The top of the trees had been cut two years before, and the lower branches had borne fruit for the first time in many years. From one-third to one-half of the top of a tall tree can be cut out at any time when dormant. A trunk six inches or more across can be sawed off just above a side limb, and the top removed.

The method above described will, of course, force the formation of water sprouts throughout the remaining living parts. Some of these should be left to use in forming a new low top on the tree, but most of them should be removed by cutting again during another season, when the top may be brought still lower, if desired. The low-headed, open, spreading tree facilitates all the essential horticultural operations, such as pruning, spraying, thinning and picking the fruit, and also insures higher color and greater freedom from windfallen fruits.

It must be remembered that there are not nearly so many windfalls under low-headed trees as there are under tall-headed trees of the same kind. Also, when apples do fall from the low trees they are not damaged so badly as when falling from the high ones. It appears that the wind does not have as much effect on low trees as on high, and, consequently on the former, there is nowhere near as much loss from this source.

Picking apples from low-headed trees can be done with much greater safety to the pickers, with less damage to the fruit, and in less time than in picking it from tall ladders. It is too often damaged by dragging it over the ladders or limbs in climbing down the tall trees. All such bruising should be avoided.

The vessels used in picking become important. The old-style method of picking in grain bags swung over the shoulders of the operators should be discarded. This gives opportunity for each apple to rub against its neighbor, and there is danger of the stems cutting the skin and making bruises where disease germs will enter as well as general bruising, and rubbing from the surface of the fruit the fine waxy covering which is called the "bloom," and which

is really a natural antiseptic coating keeping out disease germs. The polished apple may look nicer than one that has not been rubbed or polished, but it will not keep as long, and it is not in its natural condition.

Apples picked in bags will be much more injured in the process of handling than those picked in baskets or buckets. The best picking vessel is a basket with a smooth bottom of flat wood, which can be lined with cloth to prevent bruising.

The picker should avoid handling fruit of any and all kinds more than is necessary. Where the fruit is properly grown, and of uniform size and color, it does not need to be graded or sorted, and, consequently, it is by all means cheapest and best to pick it and put it directly into shipping packages. It must be understood that the more any fruit is handled, the more it is liable to be damaged by bruising. The grower should make a study of the best methods of gathering his fruit and putting it upon the market with the least amount of handling or turning from one vessel to another.

Bruises not only spoil the appearance of the fruit, but they detract from its keeping quality. In most cases disease germs enter and decay commences where the skin is broken. Of course, over-ripe fruits are more liable to be damaged than those that are picked at the right time. Thus the grower should make a study of the time of picking, and perform all operations at the season that is most timely to obtain the best results.

GRAFTING AND BUDDING.

It is a matter of common knowledge that seeds of improved varieties of fruits and nuts when planted will not, as a rule, produce trees which bear the same quality of fruit. A peach seed of the finest of freestone variety will usually produce a "cling," and trees grown from the seeds of the Bartlett pear will produce fruit of a quality inferior to that of the parent tree. This is explained on the ground of "reversion to the original type" from which the improved variety was derived. Occasionally, however, as a result of variation, a superior quality of fruit will be produced on seedling trees, and this may become the basis of a new variety when propagated by grafting, cuttings or budding. This brings us to a consideration of the science and art of grafting, which occupies an important place in the domain of horticulture, since by means of this process plants of desired quality,

as well as non-seed bearing plants, may be propagated on a commercial scale with certainty of results.

The term "grafting" in its wide sense comprises the process or operation of transferring a living part of one plant onto another with the intention that the part shall produce a growth upon the foster root which will have all the characteristics of the plant from which it was cut. By this means it is possible to perpetuate varieties of plants of certain desired quality or habits, and even continue any variation or type of any variety, which is the chief office of grafting. It is also employed in cases in which plants do not bear seeds, or in which seeds do not come true to name or are hard to germinate, or when the plants cannot be propagated by cuttings. Another purpose of grafting is to produce some marked change in the nature of the scion, as for example, rendering it more dwarfed,—as in the case of dwarf fruit trees.

Still another object of grafting is to adapt plants to adverse soils and climates. A sample of this is the general use of the peach stock in the southern States upon which to bud the plum, and working the apple on roots of the Siberian crab to make them sufficiently hardy to withstand a very severe climate.

The extent of the effects of the stock on the scion is still a matter of dispute, but it is mechanical rather than physiological. This is illustrated by the process of dwarfing fruit trees in which standard fruits are grafted upon stocks of smaller sized varieties. Pears are dwarfed by grafting on the quince, and apple by working them on Paradise or "Doucin" stock. In these cases the stocks dwarf the scions, and the result is a dwarf or smaller sized tree of a standard variety of fruit. Vigorous stocks increase the growth of the scions. Thus, top-working such varieties as Northern Spy and Greening, which are vigorous growers, increases the growth of varieties whose habits of growth are not so vigorous. As a rule, however, each part of the combined plant, the stock and the scion, maintains its individuality.

There are instances, also, where scions from very vigorous trees have been worked upon less vigorous varieties, which have tended to make the roots grow deeper in the soil. There is, also, a case cited in which the Clairgeau pear grafted upon a variety known as the Astontown,—pears which are very different in shape,—produced pears of a shape intermediate between the two.

There have been described over one hundred different kinds of grafting, but in general all grafting may be classified into four groups, viz., 1. Bud-grafting, or budding. 2. Scion grafting, or grafting proper. 3. Bridge grafting. 4. Grafting by approach, or inarching.

Scion grafting proper, differs from "budding" in that a woody scion or twig is inserted into the stock instead of a single bud. Among the many kinds of general grafting the most common are:

(1). *Budding.* The operation of budding consists of inserting a single bud underneath the bark of the stock. This may be done whenever the bark will peel, and buds of proper maturity can be obtained. Usually this takes place in the early spring and late summer or early fall, and the operation in the nurseries is, therefore, done at those times. In fall budding, the buds are obtained from twigs of the same seasons growth, while in the spring they are cut from the previous seasons growth. Nearly all varieties of trees are budded in the nurseries including peaches, plums, cherries, and most stone fruits, and also apples and pears in the eastern United States. Buds can also be inserted in the new growths in the tops of young trees instead of scions for the purpose of changing the tree into a different variety. Since it is preferable to set the buds into twigs of the present seasons growth rather than in those two or three years old, these are better cut back and the buds set into suckers instead.

The process of budding may be described as follows: The budder selects the cutting of mature buds, which is called the "stick." Since not all of the buds are of equal value, the budder rejects those from the top and bottom of the seasons growth. In fall budding the leaves are still on the sticks, and these will be cut off, leaving about one-fourth inch of the leaf stem for a handle to the bud.

The ordinary operation of budding is often called shield budding, from the shape of the cut bud. Placing his thumb upon the bud on the stick the budder passes a sharp knife beneath it, cutting just beneath the bud and slightly into the wood. If a little shield of wood be removed with the bud this will not interfere, as a rule, with its growth, and by many budders is not removed. Most budders cut all the buds on a stick before using them, allowing each to remain attached to the same by a small connection of bark, which is cut off as the buds are needed.

The stock should be prepared by removing the leaves and twigs for several inches about the point into which the bud is to be inserted. Stripping them off three or four days previous to budding, however, often results in drying up the sap, and thus interferes with the operation. Buds are preferably inserted within two or three inches of the ground, so as to avoid the growth of shoots from the stock below the bud, and on the north side in order that they be shaded from the sun.

With a round-pointed or thumb-shaped knife the budder makes a T-shaped incision just through the bark. The crosswise cut is made first, and when the vertical cut is made the knife is deftly

turned from side to side to loosen the triangular flaps of bark between which the bud is now inserted, being shoved entirely within the cleft. The bud is tied with four or five turns of raffia, the lower end of which is held by being covered with one of the turns, and the upper drawn into a notch cut into the side of the stock.

The bud set in the fall does not develop into a shoot during the same season, but merely grows fast or sticks to the stock. A few weeks after setting of the bud the tie is cut so as not to interfere with the growth of the stock. The following spring the tree is cut off an inch above the bud.

In the southern part of the country peach trees may be large enough in the early part of the summer to bud them the same season the seeds are planted. This work is usually done during the month of June, and for this reason such budded peach trees are called "June buds." Care must be taken to keep the stock trimmed of leaves and shoots in order to secure proper growth of the bud.

(2) *Cleft-grafting.* This consists of inserting a wedge-shaped scion into a cleft or split in the stock. It is preferably used in stocks an inch or more in diameter, and for this reason lends itself readily to topworking all kinds of trees. The stock is cut off and split with a knife made specially for the purpose. The cleft is then pried open, and the scion inserted in such a manner that the cambium layer of the stock and scion meet. The contact of inner bark layer of each is the essential point. The placing of the scion is the most important operation of grafting, and upon this depends largely the success or failure of the work. Shape the scion in such a manner that the outer side of the wedge is slightly thicker than the inner. It is well also to set it in the cleft in a slightly slanting position, in order to insure the cambium layers of the scion and stock to meet. The entire cut surface is then securely waxed to prevent injury by evaporation.

Cleft grafting is performed in early spring before the time of the bursting of the buds. The scions should be cut from the last year's growth while yet perfectly dormant and stored in sand or sawdust in the cellar or other cool place until the time for grafting. Twigs for use as scions can be kept in good condition by inserting the cut ends in potatoes.

Two scions are usually set in each cleft, thus doubling the chance of success. After a year one should be cut off and the other tipped to make it branch. It is important to prevent the growth of twigs near the graft, so as to give it the undivided supply of sap.

Grafting wax can be either purchased in agricultural supply stores or made. One of the best formulas is the following:

Rendered tallow, 1 part.

Beeswax, 2 parts.

Resin, 4 parts.

Melt all together, and pour into a pail of water to harden. Then pull it until it becomes light colored and develops a grain.

(3). *Bridge Grafting* is a modification of scion grafting, and is used to bridge wounds or girdles, such as are made by mice and rabbits during the winter. The edges of the girdles are trimmed back to the living bark, and scions cut to the proper length to bridge the wound, whittled wedge-shaped at each end and inserted in clefts in the bark above and below. The edges of the bark and ends of the scions are then bandaged and waxed as in cleft grafting.

Bark-grafting or Crown-grafting is a method used in grafting large limbs, and, which are therefore, not suitable for cleft grafting. By this method the scions are cut thin, and inserted between the bark and wood of the stock. The bark is then securely bound and the cut surface waxed.

Whip grafting is used on very small stock, and in the nursery, especially in the West where it is employed in root grafting apple and pear trees. In this operation the scion and stock should be of about the same size, so that the slanting cut on each will fit together. A split, forming a tongue, is cut into the scion and stock so as to hold the parts together more securely. The graft is then bound with waxed cord, which is covered over with wax only when the graft is above ground after planting. Root grafting can be performed during winter, and the stock stored until time of planting in the following spring.

(4). *Inarching*. This form of grafting is used only where union takes place with difficulty, or to unite two branches into one in order to make individual fruits grow larger, as for use in exhibits. For the latter purpose a twig from the same tree is joined to a limb just back of the fruit, and the extra supply of food will cause the specimen to grow larger.

For inarching, the twig to be grafted is bent over to the stock, and cuts are made in the side of each so that the cambium layers fit one upon the other. Scion and stock are then bound securely together and waxed. When the graft has become thoroughly established the scion is severed from its own root, and the top of the stock above the joint is cut off. Inarching is rarely employed anywhere on a commercial scale, but has its uses in the greenhouse especially, when it is desired to transfer the top of one plant to the root of another.

SPRAYING APPARATUS.

Spraying fruit trees for insect pests and fungous diseases has become a regular and necessary practice in the orchards of all sections of the State, and is now regarded everywhere as one of the cardinal horticultural operations being of equal importance with pruning, cultivation and fertilization. In fact, spraying is of greater importance than either of these, since one may be able to maintain his trees and grow fruit of a certain kind without cultivating and fertilizing the soil on which they grow, or without pruning the trees, but where spraying is neglected both fruit and trees are often destroyed and the fruit is almost always inferior. Spraying, therefore, is one essential to successful fruit growing.

The wide experience of extensive fruit growers, covering many years, has proven conclusively that fruits of the highest grade can be produced in Pennsylvania from trees of suitable varieties, planted in the proper sites, when given the necessary care, including spraying, and this at a cost which is less than the expense of the freight charges paid on apples shipped into the State from the extreme western part of the country. The abundant markets for really good fruit within this Commonwealth afford to the fruit grower unsurpassed facilities for disposing of his products directly to the consumer, and these advantages, recognized by many, have been the means of directing attention to the orchard as a profitable investment by both the rural dweller and others who are looking for means of livelihood and profit in the country.

By way of warning to the overzealous, who would rush into a new field without adequate preparation, we must say that no one should undertake fruit growing on an extensive scale for profit without first familiarizing himself with the needs of the orchard. Such premature ventures can end only in ignominious and expensive failure and vain regrets. On the other hand, fair rewards for hard intelligent labor await the wide-awake orchardist who is in love with his work, and who will care for, and especially spray and otherwise properly treat his trees intelligently, thoroughly, and opportunely for all pests to which they are subject.

The selection of a spraying outfit for use in the orchard is a matter of the greatest moment, since upon the fitness and utility of this apparatus depends to such a great extent the efficacy of the work

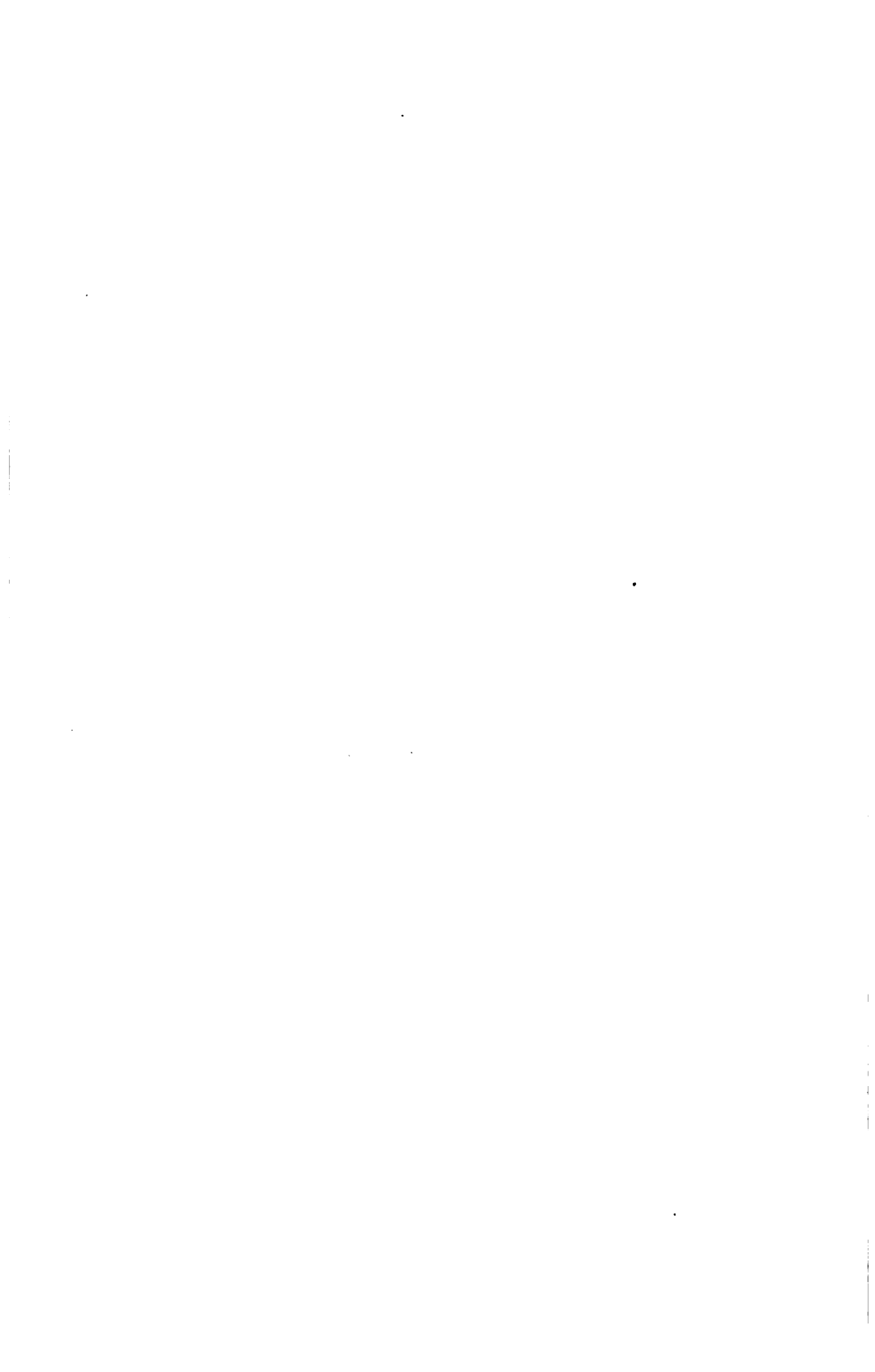




Fig. 1. Foot pump. Good for spraying small trees and a few grape vines, rose bushes, etc., poultry houses, and washing vehicles, windows, etc.



Fig. 2. Knapsack Sprayer. Good for spraying vegetables, flowers, other low plants, etc.



Fig. 3. Barrel Sprayer. Good for general orchard work in small orchard. For the average farm orchard it will be sufficient when used with longer hose and extension rod.



Fig. 4. Barrel Sprayer with Kerosene and Water Mixer. Used chiefly in spraying for sucking insects like plant lice and young scale insects.

done. The spraying outfit should thus be selected with certain considerations in view relative to the needs as follows:

1. The size of the trees to be sprayed.
2. The number of trees in the orchard.
3. The character of the orchard site.
4. Kind of spraying to be done.

In selecting a spraying outfit one must have in view not only the present needs of his trees, but, looking into the future, gauge the demands of his orchard several years ahead. Trees increase in size as they grow older, and demand more powerful machinery to treat them thoroughly as they grow larger and more fruitful. The orchardist should foresee these increased demands made by his trees upon the spraying outfit, and make his purchases and preparations accordingly.

A few small trees and bushes can be sprayed with any of the types of pump generally known as "foot pumps," (See Fig. 1) or bucket pumps, knapsack pumps (See Fig. 2), and barrel pumps (Figs. 3 and 4). Where help is plentiful and cheap such pumps can be economically employed in treating larger plantings of young trees. No one should, however, be so optimistic as to undertake to spray large apple trees with a small bucket pump or a knapsack pump. Such attempts to accomplish the impossible can end only in failure, disappointment and disgust, and an operation, which, with the proper outfit, is no more difficult nor disagreeable when done in the right way than plowing the orchard, or harvesting the crop, or, indeed, any other work on the farm, becomes, when performed with improper and poor apparatus, a trial and a drudge instead of an exhilarating exercise and pleasure.

The Barrel Pump. The barrel pump, operated by hand, has for many years been the standard in the ordinary farm orchards which consisted of but a small area. A fair grade of work has been done by these in many instances, but they are subject to several serious limitations. In the first place, the barrel pump is usually operated from either a cart, a sled, or a wagon used in moving it about, and there is thus no means provided other than the hose and extension pipe for delivering the fine spray to the tops of the tall trees; except, indeed, the operator may stand on the wagon and from this point of vantage, using an 8 or 10 foot extension pipe, he will be able to reach the tops of trees 18 or 20 feet tall. However, since the old farm orchards contain trees of 40 feet and more in height, it is necessary to supply some other means whereby the operator can reach the extremities of these tall trees, or else cut the trees back to a height commensurate with the capacity of the spraying outfit. De-

horning all extremely high trees is recommended on general principles, and for the purpose of facilitating picking and the improvement of the trees, is alone worth the effort necessary to transform them into comparatively low-headed specimens. The necessity of low-headed trees for proper spraying shows our reason for demonstrating methods of pruning with those of spraying.

In case high trees are to be sprayed with a barrel pump or other hand pump outfit, a ladder in the tree must be used or a platform or tower of the necessary height must be erected on a heavy wagon to enable the operator to reach the tops of the trees with the nozzles and spray. A long, light-weight hose of at least twenty-five feet in length, and an extension rod with an eighth turn must be used. Especially does "the man behind the nozzle" need to be elevated when spraying for the Codling moth. The arsenate of lead or other arsenical mixture used for this pest should be directed downward into the calyces of the fruitlets, which can not be done when the spray strikes the tree in either the upward direction or from the side. From a raised platform the operator can, with an extension rod equipped with an angle nozzle or eighth turn, or a ninety degree angle or elbow, direct the spray in a downward course into the blossom ends of the fruit.

When spraying on a windy day it has for years been our practice to stand at one side of the tree at a right angle with the direction of the wind, and, with an elbow to turn the nozzle, the spray is driven against the wind through the tree top in such a way that it not only sprays the side toward which the nozzle is directed, but as the wind carries it back through the top it also sprays the opposite sides of the branches. With a little practice, good nozzles, and high power, one can easily spray thoroughly both sides of the trees when the wind is blowing, especially if it be a small tree and if he be careful to pass the nozzle through different parts of the top.

Another objection to the general adoption of the hand pump in spraying bearing trees is its limitations as to the amount of pressure which can be maintained constantly during the operation. In this State spraying pome fruits for the Codling moth larva is necessary in the production of sound fruit, and it is universally recommended. It is generally believed that the arsenate of lead or arsenite of zinc mixture is best applied under pressure of upwards of one hundred pounds to the square inch. This is practical only with power sprayers, but it must be plainly acknowledged that the new fads and notions in spraying are not giving any better results than those obtained in this State four and five years ago with an ordinary barrel spraying outfit in the Demonstration Orchard work in such orchards as those of the Huntingdon Reformatory and the Berks County Alms-



Fig. 5. Hand Lever Sprayer, by F. E. Myers & Bro., Ashland, O.



Fig. 6. Crop Spraying Attachment. For spraying low crops when attached to an ordinary barrel sprayer.



Fig. 7. Traction Field Sprayer, by J. R. Hillman, Shortsville, N. Y.

house, where, after only two applications with a barrel pump, the audience in the fall meeting, after careful search, failed to find more than two percent. of the sprayed fruits injured by the Codling moth.

The Upright Lever Pump. (Fig. 5.) There is a form of hand pump now commonly called "the Upright lever pump," which is a stage in advance of the barrel pump, and is so called because it is worked by a lever or handle which stands upright, and moves to and fro instead of up and down like a pump handle. Several firms are manufacturing pumps of this type and putting them on the market with good results for use in orchards of larger area or larger trees than those that can be sprayed satisfactorily with the barrel pump, yet not quite needing a power sprayer. We regard this form of pump as the highest type in power, ease of working and efficiency, of those that are worked by hand, and, consequently, it ranks next to the power apparatus.

One man can easily pump this apparatus all day for spraying with two leads of hose, and as it is generally equipped with a good, large air chamber, it holds pressure enough to permit the operator to give proper attention to driving the team, as it continues to supply power after he stops pumping, and gives much greater power with less work than can be obtained with the barrel pump. The one objection to it is the lack of an agitator in the liquid, but in our practical work we overcome this by keeping a hoe standing in the tank, and by occasional up and down motion with this the liquid is agitated by the man working the lever.

Field Crop Spraying Attachment (Fig. 6). This is an attachment that can be used in connection with any spraying apparatus that has power enough to force spray through four or five or more nozzles at once, and is generally attached to the rear of a wagon or cart with some such apparatus as a spray pump for giving the spraying power. The attachment can be purchased separately and used on an ordinary wagon or cart in connection with a barrel sprayer or an upright lever sprayer; or it can be attached to a power sprayer for field crops if needed.

Traction Sprayers (Fig. 7). The Traction Sprayer is primarily designed for use in treating vineyards, field crops and small trees. For these purposes it is ideal, as the power to work the pump is generated by the revolution of the wheels of the cart upon which it is mounted, thus saving the cost of fuel, and being of light weight it can be drawn over cultivated fields without damage to the crops. Whereas it is recommended in the first instance for this class of work, it can, in addition, be used to great advantage in spraying extensive young orchards of all kinds. For the farmer, therefore, who has field crops to spray in addition to young trees of a size easily covered by the

amount of pressure generated in driving from one tree to the next, this combination sprayer offers distinct advantages.

Traction sprayers are usually provided with a hand lever by means of which pressure may be generated while the machine is stationary. This is a valuable adjunct, since with this lever the traction power can be supplemented by hand power whenever needed. For spraying hillside orchards the Traction sprayer is well adapted, since the center of gravity is comparatively low, and especially with a wide tread there is less likelihood of upsetting or overturning than with any other machine made. The practice of driving around larger trees in order to secure power sufficient to spray them with this machine is not generally to be recommended, but as trees grow larger they can be well sprayed by stopping only at every other tree.

Power Sprayers: For the orchardist having five or more acres of bearing apple trees the power sprayer is the most convenient and economical in that a large amount of work can be done with comparatively few "hands," and at a time when the spraying should be performed. As an example, the arsenical spray for codling moth should be applied during the few days about the time or immediately after the last of the petals have dropped from the trees. A week later will not be as effective, and deferring the time may result in failure to control the pest. Many large fruit growers use one power sprayer for each twenty-five or thirty acres of bearing trees.

There are four kinds of power sprayers put upon the market, classed as follows, on the basis of the manner in which the power to operate them is generated: Gas Sprayers, Air Compressor Sprayers, Air Tank Sprayers, and Gasoline Sprayers.

Gas Sprayers: The Gas sprayer consists of an air-tank containing the liquid, which is forced out through the nozzles by means of pressure generated from tubes of carbonic acid gas with which it is connected. This outfit has largely been withdrawn from the market because of the unfavorable chemical action of carbonic acid gas upon the Lime-sulfur solutions in the tank during the operating of spraying, which precipitates calcium carbonate and weakens the liquid, and also because of the great expense of operating with gas.

Air Compressor Sprayers: (Fig. 8.) There are sprayers which are operated by a small engine, generally gasoline, which runs an air compressor, to force the air into the tank carrying the spray liquid, all being hauled upon the same truck or wagon. The liquid is forced out through the hose from the power of the compressed air in the tank, while more air is gradually pumped in to maintain a high and uniform pressure. The great advantage of this kind of compressor over the air tank sprayer is that the pressure is maintained at practically a uniform gauge and the engine also operates an agitator, which keeps the liquid well agitated.

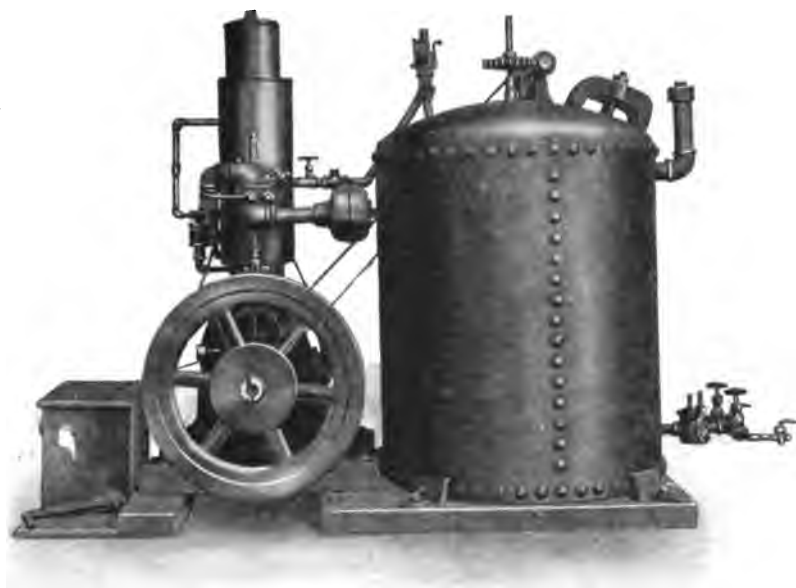


Fig. 8. Air Compressor Sprayer, by the Quincy Engine Co., Quincy, Pa. (Supplied by Mr. Pomeroy.)



Fig. 9. Air Tank Sprayer, by Latham & Co., Sandusky, O.

Air Tank Sprayers: (Fig. 9.) This type of sprayer is operated by means of tubes or tanks charged with compressed air to a pressure of from 100 to 200 pounds to the square inch. For the purpose of charging the air tanks, an air compressor, operated by an engine, is required. The tubes can be charged by direct connection with the compressor, or, to save time, from a larger supply tank which has been charged to a high pressure at the central station. The spraying apparatus proper is made of a cart, with room for two tanks of equal capacity placed side by side upon it,—one to contain the spray liquid and the other the compressed air. When reaching the orchard the two tanks are connected, and air is let into the tank containing the spray liquid as fast as needed to supply the desired pressure for the number of nozzles used. If the air tank is charged to a pressure of 150 pounds, the tanks being of equal size, the last of the spray solution will be driven out through the nozzles at a pressure of 75 pounds. The parts of the compressed air outfit consist of the following, in addition to the engine, which if a steam engine, can be used to boil the lime-sulfur, as well as run the air compressor.

The Compressor: This is nothing more than the ordinary air pump with cast iron stand and lugs to bolt it to a firm column or foundation. The piston moves in an air-tight jacketed cylinder, and this is connected with the air tank. Air compressors are of two styles, containing a single cylinder and double cylinders, respectively. The compressor is operated by a stationary engine, or the farm gasoline or steam engine, where such is at hand, will serve the purpose if of sufficient power. If such power is not already available an engine of from 3 to 6 horse-power will be a necessary part of the compressed air spraying outfit.

The Tank: This should be strong enough to stand a pressure of at least twice that likely to be applied when in use. Heavy, galvanized sheet steel is best. An extra tank will save time, and with several tanks for liquid and compressed air, as many spraying gangs as can be supplied with material will be able to operate from the same supply station at one time. If it is decided to install a supply air tank at the central station, this should contain from ten to twenty or more times the capacity of tank used on each sprayer. However, with power supplied by a strong engine and a good pump which can be operated as needed it requires but a little extra time to charge the air tanks directly. This can be done during the time the other tank is being filled with spraying fluid. The most popular size of these tanks is 50 or 60 gallons, and where the distance from the central station to the orchard is not great they seem to be the most convenient sizes. There is, however, no objection to using a larger size. All tanks should be supplied with pressure gauges.

The Cart: The simplest cart for conveying the tanks for spraying consist of two broad-tired wheels, iron axle, two thills or shafts, two wooden saddles hollowed to receive the tanks, a crossbar and whiffletree drawn by one horse or (better) a small mule.

Agitator: Two types of agitators are in use on the compressed air sprayers. One consists of a series of paddles attached to a shaft extending through the entire length of the interior of the tank. This shaft is fitted with a crank and handle on the outside by means of which it is operated by hand. Another form of agitation is produced by extending the pipe through which the air enters to the bottom of the supply tank. In this way the liquid is stirred automatically, as the air is forced up through small holes in the horizontal pipe in the liquid tank.

The advantages of compressed air outfits are: Less cost of operation; no water pump to freeze nor valves to corrode; less weight and no operating machinery to be taken into the orchard, and consequently lighter draft. This is an important consideration when used during the spring thaw, during which time much spraying is usually done.

The disadvantage consists of: (1) Greater cost of installation. The complete double-tank outfit costs more than any other, especially if the price of the engine to operate the compressor is included. In case the orchardist is already supplied with power this additional expense need not be incurred. (2) The principal objection to the use of the compressed air tank outfit in the orchard is irregularity of pressure supplied. This is a very serious objection. For example, if the air tank is charged to a pressure of 160 pounds the last gallon will be discharged at one-half this pressure, or 80 pounds. The latter could hardly be depended upon as satisfactory in all occasions.

Gasoline Sprayers. (Figs. 10 and 11.) A popular type of power sprayer at the present time seems to be that operated directly by a gasoline engine. These outfits are now made by a large number of manufacturers throughout the country.

The essential parts of all gasoline sprayers are the engine, pump, tank, agitator, truck, pressure gauge, tower and the accessories.

1. *The Engine.* Probably the most important single part of the outfit is the engine. In purchasing apparatus of this class be sure your engine is reliable, and will be ready to run under all ordinary conditions in the orchard. It should be of sufficient power to operate the maximum number of nozzles used, and maintain a pressure of upwards of 100 pounds. A two to three horse-power engine is best. Other things equal, an engine light in weight is to be preferred, but it should not be mistaken for a cheap engine of low power. The same consideration and study should be given the engine in buying a spraying outfit as would be given in purchasing an automobile.



**Fig. 10. Gasoline Sprayer in action, by the
Goulds Mfg. Co., Seneca Falls, N. Y.**



Fig. 11. Gasoline Engine Sprayer, by the Field Force Pump Co., Elmira, N. Y.

2. *The Pump.* Spray pumps are made with single, double, and triple cylinders, increasing in capacity with the size and number of cylinders used. Plunger pumps, with stuffing box which can be packed from the outside, offer distinct advantages both in re-packing and durability. Most spray liquids are gritty and corrosive, and for this reason the piston and cylinder pumps are not lasting. The cylinder can, of course, be replaced by a new one when worn out.

3. *The Tank.* Wooden supply tanks may be square, round, or half round. The square tank should be rodded so that it can be tightened when it becomes leaky. Round or hoop tanks are more difficult to tighten when this becomes necessary, especially such as are perfectly cylindrical. It can be constructed, hooped and tightened on the principle of wooden silo construction. The half round tank can be made tight readily by tightening the nuts on the clamp rods. Moreover, the best type of agitators are better adapted for use in this shape of tank than any other.

4. *The Agitator.* Agitators are frequent sources of trouble in spraying outfits, and many types are used for the purpose of keeping the spray liquid more or less perfectly stirred. All sprays that are not true solutions contain ingredients which are either heavier or lighter than water, and these either tend to sink to the bottom or rise to the top of the tank. It is, therefore, necessary that sprayers be fitted with a mechanical device which will insure sufficient agitation to keep the liquid homogeneous, or all parts of equal strength, and prevent the settling of sediment. For a true solution, without sediment, an agitator is not needed.

Many devices have been designed to secure this object, and the agitators supplied with some outfits are frequent sources of trouble. Paddles, either swinging from a fulcrum or revolving upon a crank, if they are of sufficient number, length and breadth, produce the necessary stirring, but require considerable power to operate. Sliding paddles at the bottom of the tank are effective only when the tank is partly filled, and fail to produce the desired results with the full tank. Jet agitators consists of tubes opening into the bottom of the tank through which part of the liquid passing through the pump is returned to the tank. Unless they transmit considerable volume and utilize the shape of the tank they are not perfectly satisfactory.

The most efficient type of agitator is the propellor. This consists of a spiral screw extending along the bottom of the tank. It is small in size, light in weight, simple of construction, durable and easily operated at high speed, and insures perfect mixing of the liquid at all times.

5. *The Truck.* Although power sprayers can be conveyed about the orchard on ordinary wagons, yet the special truck upon which the

spray machine is usually mounted is to be recommended. The wheels should be of wide tire and of sufficient height to make draught through the orchard over soft ground as easy as possible. The cut-under arrangement is important to enable the team to turn in small space at the end of the orchard and about the trees.

6. *The Tower.* No tree spraying outfit is complete without a tower or elevated platform on which an operator may stand to spray thoroughly the tops of bearing trees. This may be constructed either of suitable wooden pieces or of galvanized steel bars. It should be strongly made, securely braced, and fastened to the truck, and the platform surrounded by guard rails to avoid accidents to the operator. Towers can be made so that they can be folded or removed for convenience when spraying where they are not needed. It is very easy to build a tower of 2x4 scantlings on an ordinary platform or farm wagon bed.

The platform on top of the spraying tank will secure elevation of at least five or six feet above the ground, but will not take the place of the tower which raises the operator twelve to twenty feet above the surface of the ground.

7. *Accessories.* Nothing but high grade six or seven ply hose should be used on power sprayers, as the high pressure under which they are operated soon destroys poor, cheap hose, and it is false economy to use low grade. The hose of smaller diameter (three-eighths inch) is lighter and does as well. The leads for use by operators standing on the ground should be from twenty-five to forty feet in length, so as to permit of his moving over a wide range independently of the machine, thus avoiding conflict with fellow operators and the team. For hillside spraying very long hose (200 feet or more) can be used to good advantage.

Extension rods or pipes are necessary in all kinds of spraying work, and may be made of various kinds of metal. Brass and aluminum pipes are enclosed in bamboo rods to reinforce their rigidity and enable the operator to grasp them firmly. The latter object can be secured in using ordinary iron gas pipes by attaching wooden "lugs" at the points they are usually held by the operator, or by slipping them over old rubber hose, held in place by clamps or wire.

Nozzles are offered in endless variety, and under many trade names. For general spraying the large Vermorel types are to be preferred, as they throw a fine, round or funnel-shaped mist, spreading over a wide area. This funnel-shaped spray is produced by a whirling motion of the liquid in the chamber under the nozzle cap, caused by its entrance at an angle from the side of this chamber. The old, small Vermorel nozzle, with its long tortuous and inaccessible channels and cleaning device, is to be avoided, since it has long since been super-

seded by larger and better nozzles of the same general type. The Bordeaux nozzle is an example of another type, and throws a flat or fan-shaped spray. Its name would suggest that it is to be used in applying the Bordeaux mixture, but this is not the case. The best uses to which it can be put is probably in spraying for the codling moth, by the new fad method described as a "drenching force spray," and it seems to offer some advantages for this purpose over other nozzles, since the liquid can be thrown with greater force into the blossom ends of the fruits than can be done with the nozzles producing the fine sprays.

All spraying outfits should be fitted out with gauges so that the operator will know at all times whether the pressure supplied is that required for the work in hand. This ranges from 50 to 200 lbs.



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OF THE

DIVISION OF ZOOLOGY

OF THE

PENNSYLVANIA DEPARTMENT OF AGRICULTURE

VOL. II.—No. 3.

SUBJECT : BEE-KEEPING.

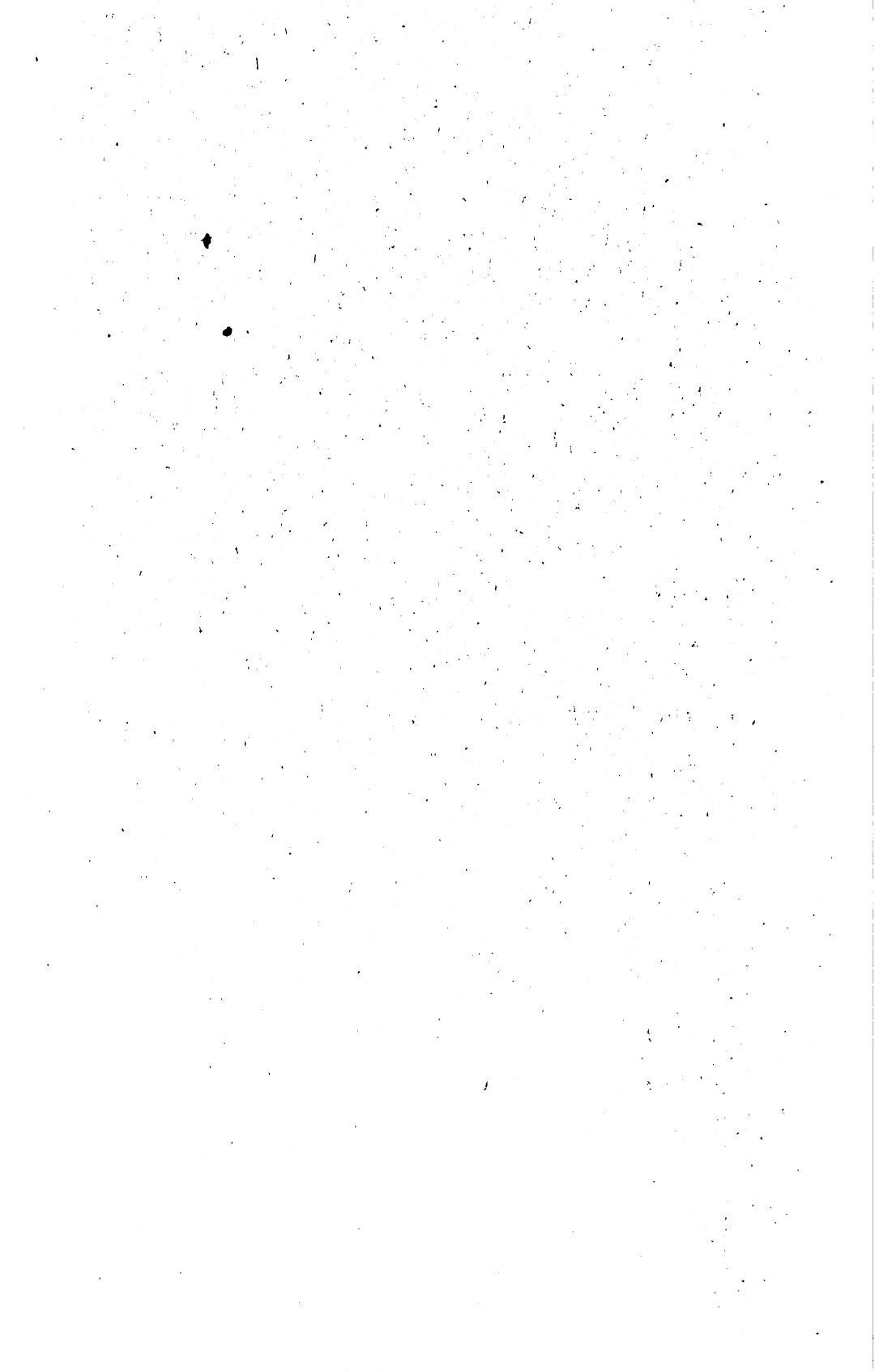
MAY, 1912.

H. A. SURFACE, D. Sci., Economic Zoologist,
Editor

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under the Act of June 6, 1910.*

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INSTRUCTION IN BEE-KEEPING.*

Preface: Bee-keeping is not as profitable nor as popular in Pennsylvania as it once was, for reasons such as the following:

1. Bee diseases of the two kinds now known as American foul brood and European foul brood, respectively, have been very destructive to the bees in over half of the counties of this Commonwealth, and at present are spreading unchecked at a fearful rate.

2. The unusually severe winters have been destructive to bees during the winter season, and have reduced them by great numbers.

3. Two or three successive very poor seasons of honey here have made the returns to bee keepers so unsatisfactory that many have gone out of the business.

4. The subject has not received nearly as much attention from various educational sources in this Commonwealth, as have other topics allied to agriculture.

5. Our citizens have, in many cases, not adopted modern methods of bee keeping, and, consequently, have not obtained the results that were possible, and have become discouraged.

This Bulletin is prepared as a publication appropriate to the season, to give present and prospective bee keepers that practical information which may prove useful during the coming summer. It may at least call attention to some helpful methods that have been found successful in the hands of some bee keepers. There are many different methods.

Bees and Fruit.

Bees for Fertilizing Fruit. It should not be necessary to call attention to the recognized value of bees as carriers of pollen for the fertilization of blossoms, and the consequent setting of fruits. While this is a secondary feature or secondary result of bee keeping, it is certainly one of great importance. It is well known that those orchards, gardens and fields that are visited by bees are much more fruitful than those which are not so attended. In this connection attention should be called to the effects of spraying while in bloom. While no successful fruit grower practices spraying while in bloom,

*For a more complete discussion of this subject see "Lessons in Bee-Keeping" by the International Correspondence School, of Scranton.

we occasionally hear various rumors of persons who have done so. Should this be done it would not only result in killing the bees, which are valuable in the orchard as pollenizers, but would also help to destroy the delicate essential floral organs, and thus reduce the crop.

We have not been able to learn of definite cases of spraying while in bloom in this State, and hope there are no persons who are so foolish as to do this. There are no pests to be killed by spraying when the blossoms are expanded, but many valuable bees may be thus destroyed. The proper spraying for the Codling-moth, which is the pest for which we spray about this time, should be made just after the blossoms fall, and repeated again in about one month.

Do Bees Damage Fruits? It is too generally believed that bees injure fruits. They do not do this excepting when the fruits are already damaged by some other cause. It is not possible for bees to bite open or puncture such fruits as grapes, peaches, etc., but when these are once injured so that the skin is more or less opened by disease germs, or by birds, or by other insects like wasps and yellow jackets, the bees will certainly suck them dry, especially if they are quite ripe and sweet. In doing this sometimes the bees render a valuable service to the grape grower, because grapes that burst in the bunch are liable to sour and spoil the bunch, and by the bees sipping up the liquids the sound berries are saved. To prevent injury to grapes from various outside causes it is best to bag them by pinning a two-pound paper bag around each cluster, just after the blossoms fall or when the fruits reach about the size of small shoot.

As the purpose of this Bulletin is to make better bee keepers rather than more bee keepers, we do not here take up a discussion of the subject of how to get a start with bees. This is very easy for those who are determined to do so. It is very evident from the frequent bad condition of apiaries and poor results obtained that what this country needs in this line is better care of the bees and the production of more honey from the colonies thus better kept. It is, indeed, possible by practicing carefully approved modern methods, which are made possible only by using modern devices.

THE RESIDENTS OF THE HIVE.

Before taking up the discussion of modern methods of handling bees to obtain good results it is well to review a few primary facts concerning these interesting insects. In fact, if the bee-keeper knew all about the structure and habits of bees, and the reasons for their peculiar behavior under certain conditions, he would not need addi-

tional information as to the practical methods of handling them, because these methods would consist of nothing more than rationally doing for them that which is best to do at the right time. In bee-keeping, as in other subjects, the proper time for any certain kind of treatment is as essential to consider as are the methods of doing the work.

The residents of the hive are of three kinds: The queen, the workers and the drones. Those that are seen flying to and from flowers, guarding the entrance of the hive, carrying honey, pollen and water, nursing the young, and feeding the queen, are the workers.

I. THE QUEEN.

This is the most important bee in the hive, because she is, under normal conditions, the egg-layer. She has but one function to perform, and that is to supply the brood chamber with eggs from which the young bees are to hatch. Under normal conditions there is but one queen to a hive, but under special conditions there may be two or more.

The queen is known by her very long and pointed abdomen, heavy thorax or middle part, and strong legs. Her wings appear to be much shorter than those of the workers, but this is because of their relative shortness compared with the long abdomen or long hinder portion of the body. When undisturbed the queen is almost always to be found in the center of the hive, or at least in that part which is set aside as the brood nest for the rearing of brood or young bees. The queen begins laying shortly after mid-winter, and increases her rate of laying as the weather becomes warmer, and as the income of honey and pollen become greater. During the height of the spring season, when flowers are yielding nectar abundantly, the queen may lay as many as 3,000 eggs per day. If this is during the season prior to a honey flow it becomes very beneficial, as the most important work of the bee-keeper is to have his colonies strong at the right time. A strong colony does not always mean good bee-keeping, because it may be strong at the wrong time,—which is after the honey flow is over.

As it takes but three days for the eggs to hatch, one can readily know if there is a laying queen in the hive by holding the comb before his eyes at such an angle that the light falls to the bottom of the cells where he can see the long, white, slender eggs standing on end, if such are to be found. The presence of one egg in each cell, regularly placed, can always be taken to indicate a laying queen having been present within the past three days. There are certain circumstances under which eggs can be found in the hive when

a queen is not present. This is after the queen has been absent so long, and so hopelessly, that there is no opportunity of rearing a new queen, when some of the workers themselves partially develop the functions of queens, and are then called "fertile workers." They lay eggs rather promiscuously in the cells, often several in each cell, frequently skipping cells here and there, which have no eggs in them. Although these cells are the smaller or worker cells, the eggs from the fertile workers hatch only drones. This is because they were not fertilized by the normal process of mating as is necessary for hatching workers and developing queens.

The eggs layed by the queen are either unfertilized, when they will always hatch drones or males, or they are fertilized, when they will hatch as females, which may become queens by special treatment of larval by the workers, or become workers by the regular treatment given the majority of the larvae.

A good queen commences laying near the center of the hive, and enlarges this brood nest in every direction as rapidly as possible, by going around it. As the weather becomes warm, and the number of bees in the hive becomes greater, and especially as the food supply increases, the workers can take care of more larvae, and the queen industriously increases the size of the brood nest, just as one would increase the diameter of a ball by adding layers to its covering. Thus the brood nest is practically spherical, whatever may be the shape of the hive. It may be so quickly crowded by honey that the queen does not have the opportunity to fill it with eggs, but as the workers generally take the honey for the young bees from the cells which are nearest them, this gradually enlarges the space of empty cells, in which the queen at once lays her eggs.

The limitations of the size of the brood nest, or the area over which she lays her eggs, are such as the following: (1) The temperature of the hive. (2) The number of bees to cover the eggs and brood, and keep them warm and feed them. (3) The amount of food coming in to supply the brood and rear the young. (4) The space available.

An unmated queen always lays eggs from which hatch only drones, as does also a very old queen when the supply of the male fertilizing element is exhausted, and as also may a queen which has been slightly injured, as by pressing or bruising the abdomen, so that she may lose power over the muscles controlling the sperm sack.

A queen mates but once, and this is for life, and while flying in the air. This is not at the time of swarming, but generally before. The queen needs her wings for the purpose of this nuptial flight. After she has once mated, and commences to lay eggs, it is best to clip one or more of her wings in order that she cannot fly again; and which, therefore, will keep her from flying away at the time of swarm-

ing. Within a few days after mating she commences laying. The fertilizing element is stored in a small sack or receptacle, and as the eggs passes down the oviduct it is fertilized by the queen letting one or more of these fertilizing cells come in contact with it. This fertilized egg then is destined to hatch a female bee, which, according to further treatment, may become either a queen or a worker. A normal or healthy queen has control over the outlet of this little sack in such a manner that she can apparently retain the fertilizing element, and lay eggs without their having been fertilized. These unfertile eggs hatch as drones. Thus it can truly be said that a drone has no father, but does have a grandfather.

The increasing temperature, and especially the increased income of sweets to the hive, greatly stimulate the queen to further laying. Her duties are so specialized that after mating her energies are entirely devoted to the one function of egg laying. She does not even digest her own food. This is pre-digested, and offered to her by attending workers. It is, of course, taken from the stored food in the hive. As it is digested by the workers, this relieves the queen of the need of expending energy in this process.

The queen continues laying fertilized eggs or worker eggs wherever she can find empty cells within suitable reach of the brood sphere. As the young bees emerge as adults from the cells previously used she returns to these, and lays in them again. This results in the appearance of rings in the comb. The rings, for example, may consist of larvae in the center, a ring of eggs around these, a ring of empty cells around these, a ring of emerging pupae around these, a ring of recently capped cells of larvae or pupae around these, and a ring of nearly grown larvae around these. The explanation of this condition is that the queen commences to lay at the center, and the bees emerge first from the cells at the center and then from those outward gradually, and in turn, in the order the eggs were laid, and after the queen filled the outer cells with eggs she found the young bees emerging from the central cells and returned to these and laid eggs in them again, gradually going over again the area of enlarging the circle by refilling the cells as fast as vacated, and reaching the point where the central eggs had been reared to larvae, and the cells just around them contain only eggs, while the next cells had but recently been vacated by emerging young bees, and were not yet visited again by the queen, while around and just outside of the vacated cells the emerging or capped bees of the previous laying were yet to be found.

As the colony becomes more populous and more honey comes into the hive the workers construct larger cells, known as drone cells, and in these the queen lays unfertilized eggs, from which hatch the

drones. As the season advances, and the size of the colony and the stores increase, and especially as the increase in colony means less room in the hive for the comfort of the bees, less area for laying eggs and providing stores, greater heat in the hive by the activity of the inmates, and less pure air for their needs, and consequently greater need of ventilation, conditions become adverse or unfavorable to the happiness of the hive occupants, and the workers commence to draw out little cups shaped like tea-cups, which are called "queen cups." The queen may sooner or later deposit eggs in these, or it is believed by some persons that the workers will transfer eggs from worker cells to these queen cups. At any rate, it is very certain that the cups are started before the eggs are placed in them, excepting when the colony is suddenly rendered queenless, when cups are built around larvae. Either the queen or workers may place fertilized eggs or worker eggs in these cups, and then the workers commence to place in them their food substance known as "bee milk." As the larvae hatch they are fairly deluged with this digested bee food, and increase in size very rapidly. The regular three days are required for the hatching of this egg, which is now destined to become a queen. The larva is so strongly fed that it grows more rapidly than the larva of either workers or drones, and consequently becomes a full grown larva and ceases feeding in seven days. As it grows, the cell is built around it and enlarged and turned downward, until it resembles more than anything else a single-jointed peanut. After it is capped or sealed the inmate transforms into a pupa and remains in the cell for five days when it cuts its way out by cutting a circular flap around the apex or tip of the cell, and crowds out by raising the lid. It is often attended by a number of workers which keep it in the cell for sometime, feeding it but preventing it from coming out. As soon as it does come forth it is liable to make a tour of the hive, and destroy all other queen cells containing young queens by biting into them from the side. Thus, when empty queen cells are to be seen in the hive it is an easy matter to recognize whether they contained queens that normally emerged, as shown by the circular opening of the apex, or whether they contained young queens that were killed by their previously maturing rivals, as shown by the sides of the cells being bitten open.

Swarming generally takes place about the time the larvae is full grown, and before the young queen emerges. It may be about the time she is ready to emerge or come from the cell. Bee-keepers can often tell when the transformation is to take place by placing the ear to the hive during the evening before and hearing a peculiar quaking or piping of the queen. Some say this is a sound made by the old queen in her fear that she may be supplanted by a new rival.

Others say, and doubtless correctly, that it is made by the new queen in her efforts to escape from the cell. At any rate, the peculiar sound, known as "the piping of the queen," is not uncommon, and is indicative of swarming quite soon. It can be imitated by a person placing his lips together and then separating them suddenly, while slowly drawing in his breath, but without enough force to produce a decided smack.

The modern bee-keeper has at hand a number of spring coils, known as queen cell protectors, which he slips over the queen cells just as soon as they are capped, and thus protects the young queens and keeps them from being destroyed when they first emerge. In this way he can save all his queens in the hive and use them for re-queening other colonies.

It should be remembered that the word "Queen" is misleading as applied to this mother bee, for it conveys the conception which we have already formed of a ruler known by that title. The queen does not rule the hive. She is strictly the mother bee or egg-layer. It is too often believed that she leads the bees in swarming. This is not the case. She is by no means the first out of the hive, and may, indeed, be well toward the last. However, the bees have enough instinct to appear to realize that upon her depends the welfare or existence of the colony. For example, when food becomes scant and starvation commences the queen is among the last to die by this means. This may be due to the two facts that as long as there is food it is offered to her, and also she is a hardy or vigorous creature. They never swarm unless there is another queen in the hive at sufficient stage of growth or development to make sure that the hive will not be left queenless, excepting when it is a "desertion swarm" intending to leave the hive from some decidedly objectionable cause. During the normal swarming season there can always be found one or more queen cells, recently capped or possibly freshly opened left in the hive after swarming, showing that a new queen has been provided to take the place of the old one which goes with the colony. Thus it can be known that the queen at primary swarming time is at least one year old.

The swarm will not fly away without their queen unless they should meet another swarm which has a queen with it. Modern bee-keepers take advantage of the fact that the bees will not abscond without their queen, and clip one or more of her wings at any time after she has commenced laying, for the purpose of preventing her escape and the loss of the bees at swarming time. This clipping can be done with an ordinary pair of scissors or with a sharp knife. The queen should be caught by the head, thorax, legs or wings, but never by the abdomen or long-pointed rear portion of the body. Press-

ing this portion of her body is liable to damage her as an egg-layer. As she does not sting her captor, she can be held in one hand while the wing is clipped by scissors in the other.

In clipping with a knife she can be held at the side of the hive so that one wing rests over the top and can be cut off by a sharp knife blade drawn across it. No pain is caused by clipping. Where the practice is to re-queen once in two years, it is a good plan to indicate the age of the queen by clipping the right wings in even years and the left wings in odd years.

As the queen never mates a second time, and never needs her wings after egg laying is commenced, this practice is commended to prevent the loss of bees at swarming time. When the wings are clipped so that she cannot fly she comes out of the hive with the swarm but tumbles about in front of it and the swarm circles and perhaps clusters for some minutes, but upon finding itself queenless returns to the hive. This may be repeated two or three times during the day and upon different days. If there is a means for her to crawl from the ground back to the hive she may do this, but it is not certain that she will. The proper thing for the bee-keeper to do is to prevent swarming, but where he cannot do this he should either use a queen cage on his hive to trap her at swarming time, or just as soon as possible after swarming seek for her on or near the ground, surrounded by a small cluster of her bees,—in many cases not more than one or two dozen. She can then be picked up and put back into the hive or transferred to another hive, or treated as directed elsewhere in this Bulletin.

It is important to remember that young queens are coming from the cells in the hive, and the owner is liable to lose his bees by one of these going out with them in swarming at some day in the near future because returning them to the original hive does not mean checking their swarming impulse. When a virgin or unmated queen goes out with a swarm they are liable to fly higher before they cluster, or to fly farther before they stop, than with an old queen, which is heavier and usually does not fly far.

The part that the queen takes in preparation for swarming consist in gradually reducing her amount of egg-laying, and her body becomes smaller in size and lighter in weight than when she is performing the function of egg-laying at its full rate. Thus the reduced number of eggs in cells in a colony, especially if occupied queen cells are also present, is an indication of the immediate preparation for swarming on the part of the queen. As her body is smaller at this time, it is also more difficult to see her than when it is more fully distended with eggs.

As soon as she finds a hive she commences to lay eggs at a more

rapid rate than before, and also do the best work more energetically in the gathering of honey, thus the colony is built up quickly with new bees and well supplied with stores for the winter season.

Although the old queen goes out of the hive with the primary swarm, it must be remembered that there may be after swarms, known as secondary, tertiary, etc., which are accompanied by virgin or unmated queens. There may be two or more of these in every such "after swarm," and a colony may continue to reduce itself by after swarms until it is, as one has said, "Swarming itself to death." The final or last after swarm may contain a great many queens. This is discussed under the heading "Causes of Swarming."

Bees commence to build queen cells as soon as they are queenless. If the queen should be lost or killed in the manipulation of the hive the keeper will find it out very readily if he should look through the hive within a few hours or a day or two, as he will see queen cups or queen cells started, especially round larvae one or two days of age. These queen cups that are due to the sudden loss of the queen are always formed around larvae less than three days of age. Cups or cells without eggs or larvae may be present, but do not indicate a loss of the queen, unless she has been gone so long that no larvae remain in the hive. If the hive contain eggs or larvae less than three days of age the bees can rear for themselves another queen, but if there are no eggs nor very young larvae in the hive when the queen is lost or killed, and also no queens present in queen cells, this colony becomes hopelessly queenless. Efforts will be made by the bees to rear queens from older larvae, which will no doubt have a stronger tendency to become egg-layers or so called "fertile workers," mentioned above. Where there are no larvae and no queen they build queen cells around some of the drone larvae which have hatched from eggs layed by the fertile workers, and apparently make every effort to rear queens from these drone larvae, but, of course, never succeed. The fertile workers, which take on themselves the partial functions of queens in their egg-laying tendency, also assume the additional character of the queen in their readiness to fighting other queens. Thus it is a difficult matter to introduce a new queen into a hive which has been queenless long enough to contain egg-laying workers. In such case the best thing to do is to remove the hive to another stand and place another hive with comb, brood, and honey on the old stand, when practically all of the workers, excepting the egg-layers, will return to the former stand. In a third way the egg-laying workers resemble queens, and this is in regard to their tendency to stay in the hive when it is moved, instead of returning to the old stand as the regular workers do.

It can be remembered by the bee-keeper that the queen reserves her sting exclusively for a royal antagonist and uses it only to fight and

kill another queen. In almost all cases queens are deadly enemies to each other, and this is why an introduced queen is liable to be fought and killed by another queen that may be in a hive where she has been introduced. Also as bees protect their own queen and ball on intruder, this is why it is impossible to introduce a new queen in a hive not queenless, and why it is necessary to requeen a colony.

However, there are cases in which the hive may contain two queens, living and working together peacefully. This is in such condition as that known as "superseding." Usually a queen lives to the normal age of three or four years or more, but after the first year or two she is liable to decline in activity and productiveness. When she commences to become unfit to keep up the colony the bees appear to realize this and construct just a few queen cells and rear a new queen, which will mate from the same hive and live in the hive harmoniously with her mother. Gradually the older queen wanes until she dies or disappears, and the young queen is then in full sway. During such time it is not uncommon to see the two queens near each other, apparently on friendly terms. Of course queens can be kept in the same hive if they are protected from attacks by one another, as in wire cases.

When introducing a queen into a new colony it is sometimes necessary for her gradually to acquire the odor of this colony or let the workers become familiar with her, or she will be attacked and killed by them. As a rule they do not sting nor bite her, but attack her by the process known as "Balling." In balling a queen the workers cluster tightly around her, embracing her as tightly as possible and squeezing her to the point of suffocation. A little ball about the size of a hulled walnut can often be seen between frames or often on the bottom of the hive where a queen has been newly introduced. Sometimes to take the queen from the hive and hold her in the hand for a time and then release her in her own hive will cause balling. This is probably because the odor from the hand has changed her scent so that the bees do not recognize her and then regard her as an intruder. Often young queens returning from the nuptial flight enter the wrong hive and are then attacked and balled by the workers. When balling occurs the queen should be rescued at once by dropping the ball into water. Attempting to forcibly separate them may result in the death of the queen by their stinging her. Smoking separates the ball, but is quite offensive to the queen.

Queens of different races are different in color and size, and also queens of the same race may vary decidedly in color. Also the progeny of a queen may be quite different from the color of the mother. For example, from a dark-colored queen the off-spring may be yellow, or vice versa.

Queens are now regularly sent by mail. They are placed in mailing cages with a number of their worker attendants and food for them. There are persons who make it a business to rear queens for the market. They sell them under such designations as "Virgin Queens," "Untested Queens," "Select Queens," "Select Tested Queens," and "Egg Laying Queens." It may pay to introduce some new blood into the apiary occasionally by means of new queens, but these should come from colonies that have made records as honey producers, rather than from those that were selected merely for color or some other purpose.

2. THE DRONE.

The drone is a big, burly fellow with tremendously large eyes, which meet together at the top of the head, and a large rounded abdomen carrying tufts of hairs, but no sting. Owing to its large size and the rounded abdomen and eyes meeting on top of the head, the drone can be distinguished readily wherever seen. The drone is present in normal colonies only when there is an abundance of food. He is apparently produced at the will of the queen when a surplus of food is coming in, and is destroyed by the workers when they commence to experience shortage. However, when a hive is queenless, and sometimes when it is unusually well supplied with food, the drones will be tolerated, and, in fact, will spend a long time, even an entire winter, in such a colony.

The workers appear to realize that he exists for the one purpose of fertilizing the queen, which is to maintain the existence of the colony by laying so many thousands of eggs. One of the early evidences of preparation for swarming is the formation of drone cells, followed shortly by the presence of drone larvae in the cells, and later by the drones seen flying around the front of the hive. After the drones appear and are on the wing the queen may be expected. They mate but once, when flying high in the air, when the drone dies instantly, and the queen returns to the hive from which she flew forth. There are often hundreds more drones in a colony than it will produce of queens, but this surplus of drones is apparently for the same purpose in Nature as the surplus or extra amount of pollen or flower dust produced by flowers, which may well go to waste rather than, through its scarcity, make it impossible for the organism to be fertilized.

Drone Comb. Drone comb is at once recognized by the very large cells which are one-fourth inch across, or four to an inch. These cells are built by the workers sometime before the time when the queen is ready to place eggs in them, but with the increasing stock of food and prosperity of a colony the queen lays in each cell one of

the unfertilized eggs, which is thus destined to mature as a male bee. The eggs hatch into larvae in three days, as do all the eggs of the honey bee, and they are then fed and reared apparently the same as the workers.

As they approach maturity in growth of the larvae the workers cap or seal them over, and again they become quite characteristic in appearance. The cappings of the drone cells are raised and hemispherical, resembling very decidedly a number of split bullets of a yellow color, lying together upon a board, with the rounded side upward.

It takes longer for the drones to mature than for the queens or workers. It is twenty-four days from the time the drone egg is laid until the winged insect comes forth. He is an easy-going fellow, apparently decidedly indifferent as to the parent colony, as he is liable to enter any colony where admitted and make himself at home. During the season when nectar is abundant and honey coming in he has an easy existence, feeding upon the food gathered by the workers, and, like the queen, living for the one function of reproduction. However, when the summer season of heavy nectar flow is past, and there are no longer prospects that new queens will be reared, or drones needed, the scene changes from being tolerated as a free boarder, and he becomes an outcast from the hive. The workers turn upon him and sting and bite him, and carry him from the entrance of the hive to be cast out. The battle of the killing of the drones is one of the conspicuous features of the bee yard, and often causes considerable commotion, as the buzzing sound is quite conspicuous. Fortunate is he who is able to find a queenless colony, or one that is decidedly over-stocked in stores.

Drones can be produced in a colony by feeding by a method to stimulate the rearing of larvae by giving food in manner and quantity resembling that of a strong natural honey flow. In fact by feeding enough sugar syrup or dilute honey to a populous colony drone-rearing and queen-production can be brought about at almost any time. However, it has been shown that over one barrel of sugar syrup would be required to produce conditions resulting in drones late in the fall of the year.

The drones can be recognized by their coarse or low droning, buzzing sound during their flight. Poultry and birds recognize and devour drones. Kingbirds, or the so-called Beebirds, feed to a great extent upon drones, and really but rarely destroy workers.

As the drone larvae are very heavy feeders it can be seen that they consume an immense amount of honey in the hives, not only in the larval stage, but also in the adult or winged stage. Not only do they consume honey, but the larvae occupy space that should be given

to the production of workers at the particular season when the workers are most needed, or space that should be used for the storage of supplies. Thus it is best to get rid of the drone comb in all colonies where not needed for breeding purposes.

Drone comb is best prevented by using full sheets of regular foundation fastened in the frames. These sheets are comb foundations, made with raised bases of the cells, which are the right size for worker cells, and if they are fastened with wire or splints they will retain the proper shape and size of the cells. If, however, they are not wired or not fastened with supports of some kind the sheets may sag, and the cells stretch, until they become too large for worker cells, and are then modified into drone cells. Where only starters of small strips or incomplete sheets of foundation are used, the space from the lower part of the comb to the bottom bar of the frame often is built out with drone comb. The bees appear to realize that a certain number of drones in a colony are essential, and make an effort in the spring of the year to build a certain amount of drone comb.

They will also build drone comb for storage of honey when nectar is coming in very rapidly. This is certainly an economy of both time and material for storage purposes, but no one can tell if the bees recognize this feature of economy, as viewed from the human standpoint.

To Get Rid of Drone Comb: Because of the consumption of food in both the larval and mature stages, and also because drones should not be reared in colonies that are not the best, it is important for the bee-keeper to get rid of drone comb. He can avoid this by using full sheets of foundation, as described above, and also by cutting out drone comb wherever it occurs, and setting in its place pieces of worker comb of the same size and shape. The bees will at once weld together the pieces in the frame, and there will not be much trouble from attempts to form drone comb again in this frame.

To Get Drone Comb: It is very desirable to obtain drone comb and drones in abundance in extra good colonies. This is obviously for the purpose of improving the apiary by proper selection in breeding or by rearing. One way to do this is to use only a strip of foundation known as a "starter," instead of a full sheet in the frame. Place the frame containing the starter in the middle of the brood chamber during the time when there is a fair nectar flow, and it will not be many hours until the workers will be drawing it down and building drone comb.

Another way is to cut a piece out of a frame of comb of any kind, and set this into the hive during the busy season of the bees. They are almost certain to fill it with drone comb. This is why, when drone comb is cut out of a frame where it is not wanted, the space should be refilled with drawn worker comb.

The third means which we have used to obtain drone comb is to set together pieces of good comb cut from other hives, and fastened in the frame in such a way that it can be given to the bees, when they will soon fasten the pieces together and proceed to make use of them.

3. THE WORKERS.

Duties: Each kind of bees in a hive has its own duties or functions to perform. While those of the worker are the most varied of all, they can not be performed by either the queen or the drones. It is the workers that build the comb, gather nectar and transform it into honey, store it and evaporate it in the cells, seal it, protect it, and also predigest it and carry it to the queen or to the larvae that are to be reared by it. It is the workers that gather pollen from flowers and store it in the cells as the familiar "bee bread; to be used as food in the rearing of the young workers and drones. It is the workers that carry water from nearby ponds, streams, or watering places to dilute the thick honey and quench the thirst of the inmates of the hive. It is the workers that feed and guard the young and the queen, and also guard the entrance to the hive. If an enemy should present itself they are willing to die in defense of the colony, as shortly after the sting is left in the victim the worker will perish from the results of its being torn from its body.

If a mouse or some other small animal should die in the hive the workers cover it over by hermetically sealing with the resinous substance known as propolis. By means of propolis the workers seal the cracks of the hive, fasten on the covers and prevent the penetration of wind and rain. It is the duty of the workers to scout the country and locate and bring food that the colony may be sustained. When the time comes that swarming is approaching the workers often go out as scouts and look up suitable places for the future abode of the colony. It becomes the duty of the worker to construct drone cells at the proper time and rear drones, as well as to construct queen cells and rear queens. Not only must they rear the drones, but when their period of usefulness is over, it is their duty to destroy them.

Not only do the workers rear the queens, and sometimes forcibly detain the young queens in the queen cells, and devote assiduous attention to the feeding of the mature queen both day and night, but when the colony becomes queenless they make efforts to take upon themselves the functions of the queen by becoming egg-layers,—as described above.

Life History: The worker is an undeveloped female, commonly called a "neuter." The egg which the queen lays, if unfertilized will hatch a drone, and if fertilized will hatch a larva, which if fed

in a certain way will develop into a queen, and if fed in another way will develop into a worker. Therefore, a fertilized egg becomes a female, of which the queen is the perfected type, and the worker is an undeveloped form.

The egg that is to be a worker hatches in three days, as do the other eggs, the young of which develops sooner than does the drone, but not so quickly as does the queen. The relative periods of development of bees are as follows:

	Egg.	Larva.	Pupa.	Adult or Winged Form.
	Days.	Days.	Days.	
Queen, -----	3	8	5	4 to 5 years.
Drone, -----	3	12	9	1 month to 1 year.
Worker, -----	3	11	7	6 weeks to 1 year.

During the first three days of the larva stage all of the young honey bees are fed upon the same kind of food, which is thought by some to be a secretion from a gland in the head, and by others is regarded as the digested food substance regurgitated by the worker. The latter view will probably prove correct. This food substance is sometimes called "bee milk" or bee jelly." After three days the workers continue to feed the larval queen upon this highly concentrated and very nourishing food substance, perhaps slightly modified, and then known as "royal jelly," but the larval worker, and perhaps also the larval drone are fed upon a mixture of nectar, pollen and "bee milk," in which the latter is gradually reduced and the former gradually increased.

The egg first stands directly upon end, in the bottom of the cell, but gradually inclines, so that its age can generally be recognized by the angle at which it leans. The young, white larva which comes forth at the end of three days is almost as large as the white egg shell, and when first hatched is the same shape. Sometimes the two are to be seen together at the bottom of the cell, and the observer may be led to think there are two eggs present, and thus see a possible indication of the presence of a laying worker.

At first the little larva lies on its side in a curved position in the bee food in the bottom of the cell. As it grows it becomes larger and assumes a circular shape. As it grows still larger it stretches itself lengthwise in its cell, and as it completes its growth, it is stretched out in its cell. When it is capped over it makes a very thin delicate cocoon of fine silk lining at the bottom and side of the cell. It then turns round, and with the head outward transforms into the pupa or chrysalis, and later opens the cell by gnawing a circular flap from the capping, when it crawls forth as a little, soft.

flabby gray-colored individual, which is apparently unnoticed by its sisters, but which crawls around and searches for honey, feeding upon the first that it may find.

Its legs become stronger, its wings strengthen, and it soon commences its duty of nursing or caring for the baby bees in the larval stage. For some time the eyes of the young bees are beset with bristly hairs, but as they crawl about in the hive these are rubbed off, and about the the time this occurs they are ready to go forth as mature bees to collect food and water for the colony. Often when the outside temperature is favorable young bees can be seen flying back and forth in front of the hive in their play flight, sometimes in such numbers as to lead to the belief that the bees are preparing to swarm. In this flight the young bee turns facing the hive, and flies up and down, and back and forth, as though making a thorough study of its surroundings, and preparing itself to recognize them during its activity as a field bee.

It is certain that the bee does recognize its colony by certain marks, such as color of the hive, some object on the cover, a pole, stone or plant or some object near its entrance, the direction of the entrance, or anything that can serve as a land mark. When the land marks in front of hives are changed, the bees often follow the land marks instead of selecting their own original hives.

Robbing: As a rule the worker recognizes its hive when it returns to it, but should it not be able to find its own hive it is welcomed in another if it should return with a load, but if it should go as a hungry bee seeking food, it receives the kind of reception that is frequently accorded to beggars or pilferers. The guards at the entrance of the hive watch for those who do not belong there, and prevent their entrance if possible. However, if one should be able to slip past the guards and load himself with ill-gotten gains, and return to his own hive, he would be followed back by some of his companions and a general robbery would commence at once, if possible. It is not infrequent that weak colonies are robbed by strong colonies, especially when the former become queenless. Also, when the bee-keeper is working among his bees after the nectar flow has become reduced, and especially during a decided scarcity of nectar, there is danger of considerable trouble through robbing.

This is best prevented by making it an invariable rule to render it impossible for prowling bees to get even a single drop of spilled or scattered honey. To aid in preventing this some bee-keepers use what is called a "robber cloth," which consists of a curtain similar to a window shade, a little longer than the width of the hive, with a heavy stick at each side, so that it can be thrown quickly over the hive that has been recently opened and may need to stand open for a short time. All work like transferring should be done under a screen except when there is a nectar flow.

Robbing is not liable to occur excepting during a scarcity of the honey flow. During such periods the bee-keeper should watch the apiary, and particularly note the results of his own work with the hives. The hive that has been smoked, moved or opened is for the time being demoralized, and robbers are liable to enter it. It is possible through carelessness at such a time to throw the whole apiary into a tumult that will prove quite serious. In some cases we have known the bees to fill the air, and search for a considerable distance for any victims that they can sting. Horses and poultry have been stung to death, and persons have been kept inside of the house by the bees in their furiously agitated condition. Robbing should be prevented by taking precautions against starting it, but when it does commence it can be recognized by the bees fighting at the entrance of the hive, and the robbers prowling around the hive, and trying to get in at cracks and beneath the cover.

One way to cure it is to paint the cracks of the hive with kerosene, using either a brush or a corn cob. When the robbers smell such detestable odors they do not apply again for admission to such a place. In combination with the kerosene painting, the bee-keeper should use wet grass, dropped loosely in front of the hive. This will permit ventilation, and will also let the bees inside of the hive work out through it, while those outside the hive will not attempt to work downward and into the hive. As a last resort a slight sprinkling with a very dilute solution of carbolic acid on the grass over the entrance will be sure to keep the robbers away, but this is so offensive to the rightful inhabitants as really to prove cruel to them.

HONEY COMB.

Honey comb or "comb" is the product of the worker, made by gorging itself on honey, and then hanging suspended and warm until, by a peculiar natural process, little scales of wax come through the pores of the abdomen. These little scales are formed only from certain abdominal segments or rings, and are passed along by the bee to the cell wall, where each is placed on edge, adding its share to building the structure.

It is known that "bee's wax," from which the comb is built, is produced by the modification of honey, and is possible only by the bee. It is also known that there is a considerable amount of honey needed to produce one pound of bee's wax. Just how much is used is not fully agreed upon by the writers of this subject, as it has been estimated variously at from five to thirty pounds, with the majority of writers agreeing upon an estimate of fifteen pounds of honey required to make one pound of bee's wax. Whatever may be the exact amount, the important fact remains that in the pro-

duction of bee's wax there must necessarily be a considerable loss of honey, transformed to make it, besides the loss of time by the bees during the period when nectar secretion is at its height, and honey production should be greatest by keeping the bees most industriously busy. This explains why so much more extracted honey can be produced from a colony of the same strength during the same season than can be produced in the form of comb honey from another in the same yard at the same time.

Bee comb is constructed generally in the form of hexagonal cells, but these are not always six-sided. In fact they may be quite variable in shape, and while the cells in worker comb will be found practically uniform in size, of five to the inch, the cells of the drone comb, constructed by the same workers, will be much larger, or four to the inch; showing that the cell formation in honey comb is not the result of some inflexible law in nature which the bees must obey if they work at all.

The same cells may be used, at different times, used for either honey or rearing young, and they may be alternately used as brood cells and honey cells. In rearing young the comb is darkened by some of the old cocoons and brown stains left by the young bees. The cell walls also become thicker, and the septum or midrib becomes thicker as the comb becomes older. Thus when the cells are smaller, the bees are not so large. We have observed that rearing bees in very old comb results in bees of smaller size. Where the comb is to be eaten it is, of course, important that it be freshly constructed to receive the honey, but where it is to be used for extracted honey, it does not stain, injure, nor in any way impair the flavor or quality of the honey therein stored and afterward removed by the extractor.

FOUNDATION.

To insure full uniform sheets of worker comb, to get rid of drone comb and of holes commonly known as "pop holes" through which the queen can pass from one side to another, and thus elude observation, and also for economy in reducing the amount of honey that must be used by the bees in comb construction, and especially to insure straight combs, the bee-keeper finds it decidedly advisable to use a sheet or septum of pure bees wax, which is artificially prepared. This is simply a sheet varying in thickness, but generally about as thick as ordinary brown paper, passed through a wax press so constructed as to impress in it the bases of the cells of proper shape to be used by the bees in making comb, and consequently called "foundation." This is not comb, but is a septum or foundation upon which the comb is built. It can be purchased in either size for worker comb or drone comb. This is all that is

artificial in the production of honey, and as it is pure bees wax, there is no objection to its use from the standpoint of the consumer. The stories concerning artificial honey comb, etc., are false. Honey can not be artificially produced nor sealed.

HONEY.

Upon the septum, either naturally constructed or of artificial foundation, the bees construct cells extending laterally or sidewise, but slanting slightly upward. This makes it possible to put in the thick honey, and let it there remain until the cell is filled. It is then capped over or sealed with pure bees wax. The color of the capping depends upon an air space between the honey and the wax covering. If such an air space is present, it is white, just as snow is white. If, however, the liquid honey comes in contact with the capping, it is watery, just as ice looks clear or watery when in contact with the water beneath, or may be white when lifted above the water.

Some bees cap the honey more uniformly and more clearly white than others. When honey stands in a damp place it will absorb moisture and the capping becomes watery. The capping of the nymph or pupa is quite different from that of the honey. The capping for the young bees is porous, making it possible for the inmates to breathe. It is also mixed with some other material, rendering it brownish in color, and is more rounded or raised than the capping of honey, which is nearly level.

"Honey is the nectar and saccharine exudations of plants gathered, modified, and stored in the comb by honey-bees." This is taken as a correct technical and legal definition of honey. Therefore, when some other substance, like molasses, is gathered by the bees and put into the cells, it is not honey. When the bees are fed syrup they can store this in their waxen cells, but it will not be honey, and can not legally be sold as such. This definition also shows that the black substance, produced by plant lice and known as "honey dew," which was so abundant in this State a few years ago, could not legally be sold as honey, although it was gathered in the order of nature by the bees and stored by them. When such material is labeled and sold it must be designated as "Honey Dew Honey," if at all.

It is important to note in the definition that to be honey it must be modified by the bee. Honey is not nectar, but it is nectar modified, gathered and stored by the bee. Nectar contains an average of about seventy-five per cent. of water; honey, on the other hand, contains an average of about twenty-five per cent. water. In the process of modification not only is the water evaporated or gotten rid of by

the bee, but the material itself is modified, possibly by coming in contact with the formic acid or some other product secreted by the little insect.

The evaporation of water from honey takes place to a very great extent while in the hive, and for this purpose the bees arrange themselves in such position as to use their wings to drive a current of air into the hive, and over the unevaporated or unsealed honey, and out ward again, thus carrying out the water in the moisture laden atmosphere. It is possible that by a special physiological contrivance the bees also extract water from the nectar and drop it in their flight. Thus it is possible that the bees start from the pasture with a larger percentage of water in their load than when they arrive at the hive.

Ripening Honey: As honey is freshly gathered and placed in the cells it is unripe, and does not have the flavor nor the keeping quality of well ripened honey. Therefore, it becomes very important for all bee-keepers to be sure that their honey is ripened before attempting to place it upon the market. Otherwise their own business will be injured. Producers and dealers should make it a rule to avoid selling unripened honey.

The shorter time comb honey is permitted to remain in the hive after it is sealed, the whiter it is, as it becomes yellowish by "travel stains," or staining made by the bees crawling over it. This yellowish tint of comb honey capping indicates ripened honey, and the consumer will soon learn that that which has been left in the hive until fully ripened is richer, thicker, has a better flavor and keeps better than that which is taken out as soon as capped.

Extracted honey should not be extracted until nearly all the cells of the comb are capped. Unsealed honey is watery, is liable to sour, and does not have the flavor nor richness that marks sealed or ripened honey. Even if it is not fully ripened when extracted, it is better to let it ripen by evaporating further in an open vessel in a dry place, instead of placing it at once in closed cans or vessels at the time of extracting. However, the best place for honey to ripen in order that it will have its full rich flavor is on the hive.

Storing Honey: Honey should never be stored in damp places. A cellar is, therefore, a decidedly unfit place. When damp it will absorb moisture and become thin, watery and soured. A dry place, such as an attic or upper room, is best. Care should, of course, be taken that it is protected from mice, rats and prowling bees, and the worm or larva of the bee moth, which will work in the edges of comb honey and effect considerable loss if permitted to do so. A box of wire screening is sufficient protection from all.

Granulated Honey: Honey submitted to alternating extremes of heat and cold is liable to granulate. Granulation is more an indica-

tion of pure than of impure honey. When it granulates its flavor is changed. It is not impaired but it is modified. Some persons prefer the granulated honey. It is certainly delicious. Yet it becomes necessary to educate consumers to use this particular form of the product. To prevent granulation, both in vessels of extracted and in the comb, it should be stored in a dry place that is of a fairly uniform temperature and never becomes very cold. Alternating cold and warm temperature, promote granulation. Warming slowly, by setting the vessel in a warm water bath, remedies it.

SWARMING.

The poor bee-keeper regards swarming as his greatest blessing, while the good bee-keeper regards it as the greatest evil. This is because the former keeps his bees in such a manner, that he removes honey from them only at swarming time, while the advanced bee-keeper makes it his fundamental rule to **KEEP ALL COLONIES STRONG**, and removes honey from the hive whenever there is enough of it in proper condition to suit him for removal. Thus the old style bee-keeper measures his success by the number of swarms he receives, while the modern bee-keeper measures his by the amount of swarming that he prevents.

The Causes of Swarming: We are prepared to make the fundamental statement that **ALL SWARMING IS TO ESCAPE ADVERSE CONDITIONS**. It is commonly said that swarming is due to "instinct," but certain facts show that this cannot be true. Some careful modern bee-keepers reduce the number of swarms to five per cent. of their actual good working colonies. If it were due to instinct such results as this could not be obtained. In very small hives bees swarm much more readily and more frequently than in large ones. "Instinct" has nothing to do with this fact. In warm weather bees swarm more than in cool. The instinct should be developed and make itself manifest under one condition of hive or temperature as well as under another.

Some say that swarming is for the purpose of propagation, but this is not true, for the reason that the queen is the one that propagates or continues the species and really lays more eggs and produces more bees when uninterrupted by the process of swarming than when so disturbed. The real process of continuing the species is that of laying eggs, and in successful bee yards where swarming is reduced to only a small per cent. of the entire number of colonies, there are more bees produced and kept than in neglected bee yards where swarming is very extensive.

It can be remembered that there are different kinds of swarming, but each can be traced to the fundamental cause of an effort to escape adverse or unsuitable conditions. Among these are the following:

1. *Starvation swarms.* These have been seen to come from the hive in mid-winter, and especially in the early spring, when there was no food whatever, and to swarm forth seeking another hive that already contained bees or food. Plainly, the object of swarming here was to escape starvation. .

2. *Desertion swarms.* Desertion swarms have occurred when the hive was filthy, as with some decayed material, or damp, reeking with foul brood, or otherwise quite unsatisfactory to the bees. Sometimes the keeper has gone to his hive and found it empty, but when examining it has found the cause for the desertion.

3. *Absconding swarms.* By this term we indicate that swarming which takes place when a swarm leaves, sometimes after it is hived and the keeper is congratulating himself upon the success of his efforts. In most cases this is a swarm placed in a new hive without food, and even without drawn comb and without brood. It will be remembered that those swarms which hung longest in clusters are the most likely to abscond or depart after having been hived. They are generally hived near the place where they cluster. Shortly after bees cluster they send out scouts to look for suitable places for their abode. When these scouts have found natural places which suit them, as the cavities in trees or buildings, or sometimes other bee hives, they return and lead the swarm away in flight. When the new hive is placed near where the old cluster was found it is an easy matter for the returning scouts to trace them by scent and enter the hive and apparently report the favorable conditions available. The adverse conditions of the warm and crowded hive, without food or young, are quickly discovered. If a frame of young brood with a little honey had been given the bees in the hive they would have remained. If the wings of the queen are clipped they may start out but return, because they realize that the greatest evil that can overtake them is that of hopeless queenlessness.

4. *Primary Swarming:*—This swarming takes place as the most ordinary method of swarming. It never occurs, however, excepting when the hive is full of honey and bees, the need of air is great, and the temperature very high. By the old queen going out with many of the workers, the number of bees in the colony is greatly reduced. Therefore, this temporarily relieves the disagreeable condition of an over-congested hive. It is a remarkable fact that swarming is prevented by various means mentioned above, and this goes to show that when the unfavorable conditions are relieved the bees are willing to remain. Finally, it should be remembered that the critical moment of swarming is after young queens have been reared and are about ready to leave the cells. The piping or quawking of the young queen in the cell, such as can be heard the day before swarming, no doubt excites the old queen, and justifiably causes her to fear the results

of a combat with one of her own kind, which must necessarily be a battle to the finish, and which is liable to end in victory to the young and more agile combatant. The old queen comes from the hive, and thus escapes the battle that may be imminent, and a number of her bees go with her and find more room and more agreeable conditions as to temperature and suitable atmosphere.

5. *After-Swarms*:—These are swarms that follow primary swarms as described above. Each is accompanied by one or more young queens. These young queens become terrified by the piping or quawking of others imprisoned in their cells by the workers, and go forth as an "after-swarm," taking with them some of the bees which at that time can be considered as field bees. These "after-swarms" become successively smaller than the primary swarms from the same hive. As the young queens emerge from their cells, and evidently foresee the dangers to them of mortal combat, they find it easier to escape by flight than by fighting, and thus there may be additional swarms. Finally, the workers guarding the remaining queens all desert their posts, and the remaining queens are allowed to come forth. One strong queen is doubtless already engaged in the act of giving battle to others of her kind, and the result is the final after-swarm, in which all of them but one takes part. As stated above, it is not unusual for the last after-swarm to contain many queens. After the colony settles down to the regular routine of but one queen the bees become contented, stop their after-swarms, and get down to business. One fact is evident,—that after-swarms are not instigated by the workers, as we know that if at the time of swarming, all the queen cells but one are removed, and that remains intact, the workers remain without any evidence whatever of after-swarms until it begins to get so congested with honey and bees as to swarm by regular swarming, for which new queens are reared.

How to prevent swarming:—This is one of the problems most carefully studied by successful bee-keepers. Prevention of swarming means stronger colonies and more honey stored, and consequently more satisfactory returns than if the bees were permitted to lose their time and dissipate their energies by swarming during the season of honey production. It must be remembered that all the honey which the bee-keeper gets is that which is commonly called "surplus." The bees will provide first for themselves all they can store in their hive body and feed to their young. When the colony is kept intact and swarming prevented there is but one hive body for honey and young bees, and most of the product of their labors is carried into the super as surplus. When a colony divides, as in the process of swarming, there are two brood chambers with young bees to be fed, and two hive bodies to hold honey, and two supers in which frames or sections must be complete before surplus can

be removed. Also, a queen ceases laying at the time of swarming, and honey production by the colony is considerably interrupted by this process. That colony which is kept strong and at work during the honeyflow will certainly yield far more honey than that which is permitted to swarm. Among the methods of preventing swarming are the following:

1. Give plenty of room. As soon as a super is full, and certainly before the honey in it is capped, it should be raised and the prepared empty super should be put between it and the hive body. As surely as the honey is left in the supere, without other space for surplus, until it is sealed it will cause such results as crowding the brood nest, lack of room for the queen to lay, lack of space for the workers to store honey, loafing on the part of the workers, over-crowding the interior of the hive with bees, over-heating the interior of the hive, and insufficient ventilation,—resulting in the immediate preparation for swarming and swarming as soon as new queens can be reared.

2. Give Plenty of Ventilation. To do this the wide side of the bottom board, if reversible, should be used during the busy season for the bees. The hive should be raised above the bottom board by placing nails under it, and the super should either be raised above the hive by placing nails under each of its corners, or it should be set back on the hive far enough to give a little ventilation under the back of the super, and further ventilation between the front of the super and the front of the hive. Each subsequent super should either be slightly shifted in its position to give some ventilation between it and its neighbor, or it should be raised and ventilated by nails beneath it. The cover should be raised by nails placed under it. Nails are used for this purpose because they are effective, when placed on their side, in giving good ventilation space without making an opening large enough for robbers to enter. During the very warm season it is better to add an extra super above, so as to provide for the greater-escape of the heat of the hive.

3. Cool the hive by placing it where it will be shaded during the hottest hours of sunshine, and also by boards placed around it in such a way as to protect it from the reflection of heat from dry ground. Use ventilated covers, or an extra board over the top of the hive, to be sure to give protection from the heat of the sun.

4. Cut out drone combs or destroy young drones in the cells whenever seen.

5. Cut out queen cells.

6. Requeen with a new queen once per year. To be sure to prevent swarming, introduce a new queen just before the regular swarming season.

7. When a colony is becoming extra strong remove from it a few

frames of sealed brood and the clinging bees (but not the queen) to start a nucleus for a new colony, and in their place put either drawn comb or full sheets of foundation.

8. Remove the honey shortly after it is well sealed, rather than letting it long remain in quantity in the hive. When the bees realize that their stores are limited they hustle for more.

9. When queen cells are found they indicate a decided determination to swarm (excepting when superseding), and cutting them out, alone, will not relieve this definitely. Move the hive to another part of the yard, and place a nucleus on the old stand. The field bees will return to this nucleus, see that it has plenty of drawn comb or foundation, and also a new queen.

10. Shake the bees, in the regular process of "shaking."

What To Do When Bees Swarm:—When bees swarm it is not necessary to ring bells, blow horns, beat tin pans, and warm one's self up generally, as this really does no good. The modern bee-keeper prevents swarming in most of his colonies, but in the few where this may be impossible he goes to the entrance of the hive, finds the clipped queen, and puts her into a hive with drawn but empty combs, or with frames with wired foundation. In order to keep her in the hive she may be temporarily enclosed in a small wire cage made to retain her or a strip of queen-excluding zinc in front of the hive. The old hive is moved to one side, which prevents after-swarming, and the newly prepared hive is given one frame of young brood and a set of frames with starters, and set on the old stand. Soon the bees will return seeking their queen, and will enter the hive. It can be left on the old stand and thus have the benefit of all the field bees. The new hive should be given a prepared super at once, as it is well known that bees work with renewed vigor after such a shake up as that of swarming. It should be said, however, that this activity can be obtained by the modern process known as "shaking," which consists in shaking the bees occasionally from the frames during the honey flow.

In case the queen's wings have not been clipped and the bees should fly and cluster at time of swarming, as will occur with most colonies in this State this summer, the best thing to do is to sprinkle or spray them with water as soon as they have settled, in order to keep them from taking flight and make them remain quiet. Then prepare a hive with frames containing wired foundation or drawn comb and prepared super over it, and place it near where the bees have clustered. Spread a sheet of cloth over the ground in front of the hive, and shake the bees onto this cloth, puffing them gently with a little smoke and make them move toward the hive. Take this opportunity to watch for the queen as they are going in, and pick her up and clip one of her wings, and let her go in with the others. At night the hive can be carried to the stand it is to occupy.

If the bees are too high to be reached from the ground it is a good plan to get them down by fastening a hoop around a wide-mouth sack, and jar them down into this, and carry or drop them to the ground. Then pour them out in front of the hive. It is best to wear a veil and keep the lighted smoker at hand.

How to Find Which Colony Has Swarmed:—Sometimes a cluster of bees is found hanging near the apiary, and the keeper knows that one of his colonies has swarmed, but it is difficult to tell which it was. By looking through the hives he can ascertain this, but he can do it more quickly by putting some of the bees from the cluster into a vessel like a small tin bucket, and swing it several times in a circle over his head, then throw the bees into the air. They appear to have become bewildered by this treatment, and instead of flying back to the cluster will fly to the hive from which they issued with the swarm.

What To Do When Two Or More Colonies Swarm Together:—It sometimes happens that two or more colonies swarm and cluster together. When this occurs the best thing to do is to prepare as many new hives to receive them as there are swarms, and divide them by shaking in the front of each of these prepared hives the appropriate number of bees that should be placed in it.

Then as soon as possible find a queen for each, and place her in a small wire box or cage, and lay her on the frames in her hive, with an empty super over them. Next place a strip of queen-excluding zinc in front of the hive so that the workers can enter but a queen can not, and shake all the bees in front of the hive, letting her remain in the cage within. They will enter through this zinc, but if there be other queens or drones these will be kept outside. In this way one can ascertain that he has separated all the queens.

Dividing Colonies or "Artificial Swarming":—Success in honey production depends upon keep the colonies strong, especially during the nectar flow, yet there are times when the bee-keeper may wish to divide his colonies to start new ones. One kind of colony division is known as "artificial swarming." Another is known as "nucleus formation."

1. *Forming Nucleus:*—In the formation of nuclei, two or three frames, containing the bees that cling to them and their brood and honey, are placed together in a hive and are given a queen or ripe cell. Thus, a nucleus is designated by the number of frames it contains. Sometimes, for the express purpose of queen mating, absurdly small hives are used which have been called "baby nuclei." The different frames of a nucleus may be taken from the same hive, or perhaps better, from different hives, thus avoiding reducing the strength of any one colony severely at one time. In this manner a

bee-keeper can form new nuclei by getting one or more frames from each hive and continuing this several times per month during the active season of the bees. If the nucleus is given some drawn comb and a new queen she will commence to lay eggs soon, and by proper manipulation and the addition of frames as needed it will soon be built up into a good strong colony. Great care should be taken in removing frames from hives that the queen is not accidentally removed with them."

In directly dividing a hive, as in one process commonly called "artificial swarming," about half of the frames are taken out and put into another hive. The queen may or may not be removed with these. Frames with drawn comb or full foundation are put in place of those removed, and the same kind are also placed in the new hive to fill it. If the queen has been removed to the new hive, her absence from the old hive will become manifest within less than a day by the presence of queen cups around young larvae, above described. If she has not been removed to the new hive the queen cups will be seen in the latter within a few hours. At the time of division a new queen or a ripe queen cell should be ready to put into that part of the hive which is thus made queenless.

It must be remembered that naturally the older bees, known as "field bees," will return to the old stand. Therefore, it is a good plan to transfer the queen to the new stand, which favors the old hive by the return of the field bees, and also aids the new colony by the continuation of the laying of the queen.

A board frame, known as a "division board," is sometimes used at the side of a nucleus for the purpose of constructing the size of the hive and making it unnecessary for the bees to generate enough heat to warm the entire interior of a hive that is larger than they require. Such a board is sometimes so constructed as to hold liquid food that may be poured into it, and is then known as a "division board feeder."

2. *Shook Swarming*:—By this term is meant that form of artificial swarming which is produced by shaking the bees from the frames into a hive prepared for them. It divides a colony in the same manner as regular swarming, and starts the bees to work in a very active manner, similar to swarming. It has the advantage of being under the control of the operator, and will prevent swarming by the colony that is shaken.

To make a swarm or new colony by shaking can be done by one of two methods:

- (1) Shake all the bees from the frames on one hive only.
- (2) Shake one or more frames from each of two or more hives. This means merely to lift the frame from the hive and shake it before the new hive that is to contain the new colony.

In doing this care should be taken that the queen is not removed from her hive. It is an easy matter to make up a new colony in this way by shaking a few frames from populous hives without at any time seriously interrupting the work of any one colony.

When a new colony is started, on an artificial swarm produced, it should, of course, be given a queen at once, or what is an equivalent is a ripe queen cell. To make sure of its staying it can be given a frame containing honey and young brood. Such new colonies are generally made up at a time when there are a number of good queen cells available, and one of these is given to each colony by cutting it out of its original comb and fastening it, by means of pins or otherwise, to some comb in the new colony. The young queen will emerge, mate, and lay eggs, and build up a colony.

THE STRAIN OR KIND OF BEES.

There are several different races or strains of honey bees, but the one that will be found best suited to all needs in this State is a good strain of pure Italians, reared from strong, producing colonies. Every once in a while there is a popular effort toward introducing some other races or strains of bees, but when all is told or balanced it will be found that the Italians are the best for us. Concerning all the other races something more objectionable can be said. For example, the Blacks or German Black bees do not take care of the bee moths or "worms" in the hives and clean them out, as do the Italians, although it is true that they produce comb honey of remarkable whiteness in capping. Also they are more variable in disposition, and more liable to be quite cross, than are the Italians. The cross breed between the Blacks and other races is particularly liable to be cross, and to attack persons to a very disagreeable extent.

The Banats were supposed to be exceedingly profitable as honey yielders, have not proven to be any better than Italians with no proven point in their favor. The Caucasians and Carniolans are greatly inclined to swarming too much, and produce unusually large numbers of queen cells and new queens at the time of swarming. They are not more prolific honey gatherers, and produce no finer honey than is produced by the Italians. While they are gentle, these races do not hustle during times of scarcity to gather what little is to be had as do good Italians, and especially Cyprians. The Cyprians are hustlers for hard work and are industriously active, but they are high-tempered fellows, difficult to handle, and liable to become uncontrollable. We have seen Cyprians boil out of hives like water, paying apparently no heed to any amount of smoke that is given them. A strain of Cyprians in an apiary will make itself manifest

by crosser bees for many generations. They do not produce enough honey more than Italians to justify one in keeping Cyprians in the yard.

After all is considered, the bee-keeper is engaged in his business for the sake of honey production, and what he needs is bees that will produce nice honey in abundance, take care of their hives against enemies, be sufficiently gentle to be reasonably controlled, and not swarm themselves to death. The Italians meet these conditions. The bee-keeper should remember that there is a remarkable difference between different colonies of bees in the same apiary. In fact, the differences between colonies of the same race are liable to be as great as those between individual human beings, plants, or animals. One colony may be remarkably gentle, while another may be inexcusably cross, and another may be intermediate between these. One colony may find and store nectar in surplus, while another is idle because of scarcity of food. An individual colony may seal honey in such a way as to make it look greasy or watery, while another may make it appear unusually white. One colony may make the cappings of the honey sections rough or uneven, like a wash board, while another may make them quite smooth and even. One colony may make a great deal of burr comb or cross combs between sections or combs, while another may not build it to any extent. One colony may fill every accessible place in the hive with bee glue while another may not stick together the frames with much bee glue. It is important for the bee-keeper to watch bees and note the different results in each colony, and eliminate those that are objectionable. This can often be done by changing the queen. A change of queen means an introduction of new tendencies, and new inheritance among the progeny of the new queen. One will be surprised to know how much of a change is made in the product of a hive by changing queens. It must be remembered, however, that a change will not always result in improvement, because there is no proof that the progeny of the new queen will be better than that of the old.

In consideration of the fact that honey-production is the chief object in bee-keeping it is advisable for the owners to keep records of each colony, and gradually eliminate those which are least productive. To do this it is very important to breed both queens and drones from the most productive and most satisfactory colonies. (See "How to Improve the Product of the Apiary").

SUPPLIES OR ACCESSORIES.

The "accessories" are supplies which the bee-keeper should have to make it possible for him to succeed. Without modern equipment he cannot practice modern methods. Among the various supplies which he needs are the following:

(a) *The Hive*.—Besides the bees, the most important accessory of successful, modern bee-keeping is the modern frame hive with removable frames, so the operator can open it and remove the combs with clinging bees, and examine it easily at any time he may wish to do so. With such hives it is possible to practice modern manipulation, to detect diseases and cure them, to remove worthless queens and introduce others that may be better, to remove drone comb and otherwise prevent an over-population of drones, to practice shaking, dividing colonies and "artificial swarming," to find the queen and clip her wings to prevent bees flying away at swarming time, to increase the number of colonies rapidly and easily, to find if combs are infested with worms or other pests, to determine the amount of stores or food present, to feed them easily, to exchange frames and combs of different hives, and otherwise to manipulate them in a manner that could not be done with the old style hive or box hive.

Let it be remembered that a movable frame hive is no better than the old box hive if the combs are built crosswise or fastened together in such a way that the individual frames, with their contained comb, can not be lifted out or moved as desired.

The hive which we recommend in bee keeping for general purposes is known as the ten-frame, dovetailed, single-walled hive, carrying ten standard frames known as the Hoffman L frame. This hive can be equipped with supers or top parts to carry honey sections of any desired size, but the size of the section most recommended is the 4x5x1 inch section.

It is really better to order manufactured hives than to attempt to make them for one's self, for the reason that a slight variation in the construction will render them non-interchangeable if any of the parts are defective in some way. Various parts of the hive are made to accommodate other parts to the fraction of an inch in measurement; and the exact bee space of three-eighths of an inch in giving room for the passage of bees, in many ways, as to and from the super, is very important.

Hives made by machinery are not only accurate, but they are really less expensive than those made by hand. Several firms now make standard supplies for bee keepers. It is especially important that all supplies in one apiary be uniform or interchangeable. When there is a mixture of hives of different kinds it is impossible to practice proper methods of manipulation. In buying new hives all that is necessary is to state the size of the hive as to the number of standard frames it is to carry, and the size and kind of section that is to be used.

Double-walled or Chaff Hives: In cold climates double-walled or chaff hives are quite popular for supposed better results in wintering. These hives are built with two walls around each side, and the space

between the walls is filled with chaff or some other heavy material to prevent the loss of heat from the interior. They are heavy and cumbersome, and are not exactly adapted to modern methods from the fact that the bottom boards are fastened to them, and thus a lower space can not be widened for better ventilation. They are generally in the eight-frame size, and are then equipped with the useless little board known as the "starter," or "starting board," which practically all eight-framed hives are supplied.

Experience during the severe winter of 1911-12 proved conclusively that the chief factors in wintering successfully are plenty of good stores and some protection from exposure; and that the double-walled hive gives no better results than does the single-walled. In addition to the greater weight and their firmly attached bottoms, another objection is that they are more expensive. They are not needed in Pennsylvania if bees are properly prepared for the winter.

Painting Hives:—Hives should be painted in order to protect them from moisture and from sun-cracking. A painted hive will be serviceable many years after one not painted has decayed. Ordinary house paint is well suited for this purpose, but it is evident that the color should be white rather than black to prevent penetration of heat of summer.

(b) The Bottom Board:—This may be a plain bottom board, with edges raised around it to give space for the entrance of the bees, or it may be so constructed as to be reversible. There is not much need of the reversible feature of the bottom board. The side giving the larger opening is used during the busy summer months for larger space and ventilation of the bees, and is also the side that is used during the winter to prevent clogging by dead bees that may drop between the frames.

Some means should be taken to mark the hives where there are several in the apiary, placing large and conspicuous marks so that the bees can see and use them as guides, to enable each to find his own home. Stones, sticks or boards placed in position near the entrance of hives may be useful in this regard. Also, each hive should be marked with a conspicuous number, in order that the owner can keep records of it by its own respective number.

Among the parts of the hive for consideration are the following:

(c) The Cover:—There are several forms of covers for hives, but it is enough to say that the under side of the cover should be flat so it can be put on by sliding from either side, and thus avoid crushing the bees, as would be done by one that can be put on only by dropping it from above. It should also be water-proof, and should fit the hive tightly enough to keep out other bees, insects, wind, etc. A

cross piece at the end to keep it from warping is quite desirable. Covers and bottom boards should never be fastened to the hive by nailing or otherwise, but should be left free.

(d) *The Frames*.—The exact size of the frames is very important. In ordering modern frame hives one is able to obtain frames of regular standard size, $17\frac{7}{8}$ inches by $9\frac{1}{8}$ inches, made exactly to fit the hives, and give the proper bee space of three-eighth inch at the various places where they are required. In making hives and frames it is necessary to keep in mind that the bee space is three-eighth inch, and that this amount of space is needed between the frames and the hive all the way around and also between all frames, in order to make it possible for the busy bees to find room to get around. If a less space than this is allowed it will not give passage for the bees, and they will cause trouble by closing it with propolis or bee glue. If greater space is allowed they are liable to build combs in it, and thus also cause trouble.

The best form of frame is the modern standard frame known as the Hoffman L frame, standard size $17\frac{7}{8}$ inches by $9\frac{1}{8}$ inches, which is suspended by hanging at the ends of the top bar, and may be either self-spaced, by a projection of the thick end bar of the frame, or staple-spaced by means of staples driven into them to keep them the proper distance apart, or entirely unspaced. The plain top-bar, staple-spaced frame is best. The spacing of the frames at the exact distance is very important. If they are crowded too closely together the bees cannot get between them to pass from the brood chamber beneath to the honey super above. If they are too far apart there is the possibility that extra combs will be built between them, or the brood will not be kept properly warm.

Spacing at the proper distance is effected by driving very small staples into the sides of the top bars of the frames at such a distance ($\frac{3}{8}$ in.) as to make a bee-space between all frames and also at the sides of the hive. It is also important to staple the ends of the frames so that in lifting them out they will not swing against the ends of the hives, and crush the bees in so doing. A small staple should be driven into the upper end of each end bar of the frame, and one should also be driven into the lower end of each end bar, in such a way as to keep the end of each frame one bee-space away from the end of the hive. The greater advantage of the staple-spaced frames is that there is much less propolis or bee varnish used on them than on the self-spaced frames where there is a margin of 3 or 4 inches of wood of each frame coming in contact with that of its neighbor. The more the points of contact are reduced in number and extent in the interior of the hive the less is the amount of propolis used. It angers bees considerably to open their hives when the frames are fastened together with propolis, as the jarring or jerk-

ing caused by separating them is one of the causes of anger, and this can be avoided to a considerable extent by the use of the staple-spaced instead of the self-spaced frames.

It is very important that all frames in the same apiary be of the same size. Without this it is impossible to practice modern methods in bee-keeping. If bees should be purchased in hives that do not contain frames the same size as those already in use the bees should be transferred to frames of uniform size. (See Transferring). This is why standard frames should always be used. Bees on standard size frames are worth twice as much, for sale, as those on other sizes.

(e) *The Alighting Board*.—It is best for each hive to be provided with a slanting board in front of it for the bees to alight on, and called “the alighting board.” The advantages of such a board are as follows:

1. The fatigued bee, coming in with its heavy load, has a comfortable place to stop from its flight.

2. It is not in danger of being dashed into mud by pelting rain drops, nor being lost in the grass, nor being snapped up by toads, snakes or mice.

3. Grass and weeds are thus kept away from the entrance of the hive, and this is an important point. Grass in front of a hive, through which the bees must fly, does more than anything else to wear out their wings, and the age of usefulness of a bee depends upon the duration of its wings. When these wear out by flying through weeds and grass its services are soon ended. When it becomes useless it is ruthlessly thrown aside by its fellow workers.

4. A sloping board in front of a hive makes it possible for the workers to drag away from the entrance heavy or offensive material, like dead bees, and thus the cleaning of the hives is facilitated, and there is less trouble from moths.

5. The alighting board, extending from the hive to the ground, makes it possible for the queen with clipped wings to return to her hive after she has found that for her the swarming flight is impossible. Thus, when a swarming may occur unexpectedly the valuable queen will not always be lost, although the presence of the alighting board does not always insure that she will find the hive again.

(f) *The Hive Stand*.—By the Stand is meant the place where the hive rests. The kind of stand is important, as this should be designed to help preserve and protect the hive. A bottom board that rests directly on the ground, or on some old and decayed board on the ground, is sure to be damp, and decay in a very short time. The hive should be firmly placed, so that it will not topple over by sinking into soft ground at one side when it has a heavy load, and so that it will not be blown over by strong winds.

Low stands, like benches, can be built to hold the hive, but by all means the best, and in the long run the most economical hive stand, is one made out of concrete and cement. A concrete stand should be high enough to raise the hive above the ground a few inches, and it can be sloped at its front margin so that it will partially take the place of the alighting board. Whatever kind of stand is used should be inclined from rear to front in such a manner that the rear of the hive is about one inch higher than the front. This prevents water from rain or snow running to the rear of the hive on the bottom board, and thus rendering it damp and foul for the bees, and it is especially valuable in making it easy for the bees to get rid of the material which they must carry out in the natural process of cleaning their hives. A hive which slopes slightly to the front is much more free from worms than one that slopes in the wrong direction and accumulates wax scales where worms will feed and troubles develop.

In making concrete hive stands they can be built in the yard where wanted, and each made large enough to hold two hives. In the arrangement of hives in the apiary the operator should be able to get at each hive from the front and rear and one side. Hives should never be crowded so closely together in a row as to make it impossible to get between them, or at least to approach each hive from one side. Thus the double hive stand is all right, and at the same time economizes space. These can be arranged in rows to suit the owner, but should be far enough apart to let him pass between every two hives.

In placing the hive stands, especially if they be as permanent as one made of concrete, the direction the hive is to face must be considered. It is best to have it face toward the south or east, and particularly in a direction that the prevailing wind will not cause annoyance to the bees.

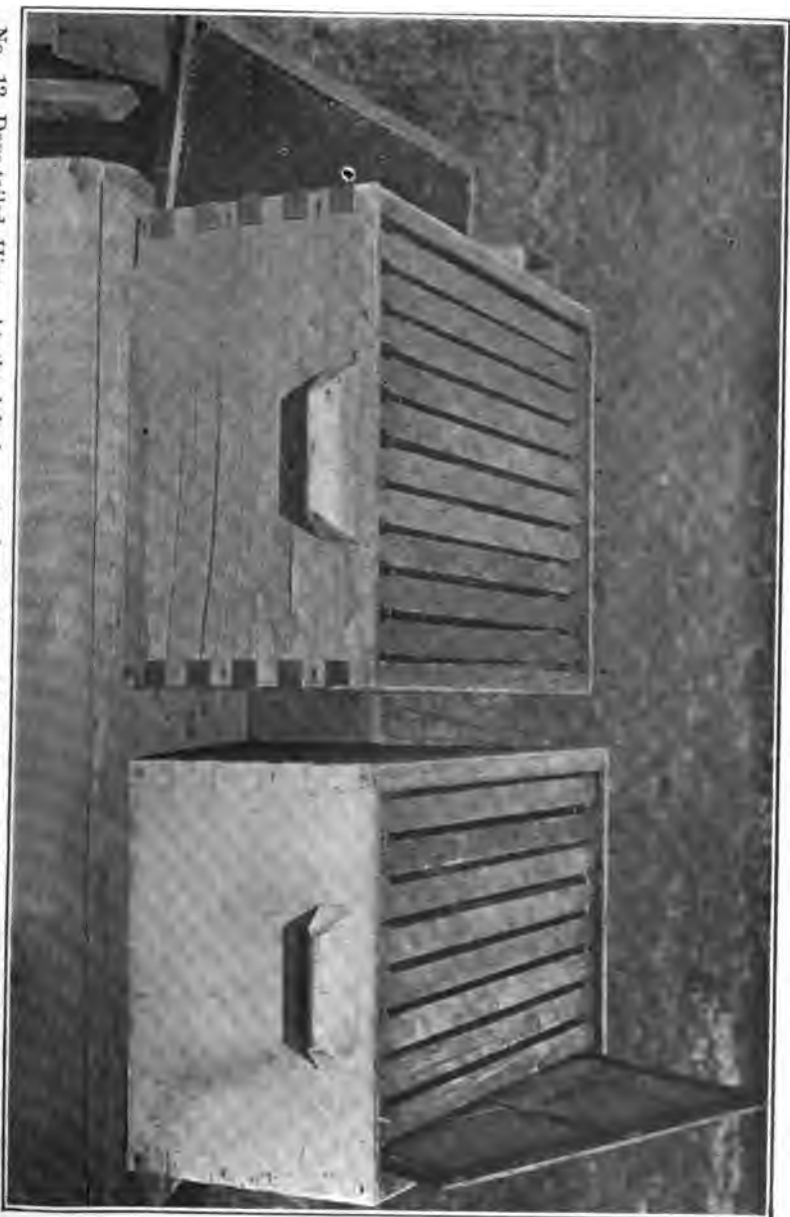
As to whether hives should be placed in shade or not is an important question. It is certain that it means comfort to the bee-keeper, who must work with his bees during the hot days of summer, to have them beneath the shade of trees, and if the hives are so placed that they will be shaded from the middle of the forenoon until the middle of the afternoon the bees will be much more comfortable, and also more industrious. Shade and ventilation are the primary requisites in preventing that form of loafing among bees that is known as "hanging out." Thus placing stands where they will be shaded at noon increases the industry of the bees, and the consequent yield of products desired.

(*g*) *The Super*.—The portion of the hive which is used above the brood chamber to contain the stored honey is called the "super."

This may be filled with small boxes, called "sections" for comb honey, or it may contain frames for holding the comb which the honey is to be thrown by centrifugal force, and which is then called "extracted honey." Frames for extracted honey may be shallow or deep, or they may be the same size as ordinary brood frames. The chief advantages in the use of the shallow frames are (1) the greater ease with which the entire super is manipulated, and (2) shallow frames filled by honey flow too scant to fill deeper. It is for each bee-keeper to decide whether he will equip his supers with frames for extracted honey, or with sections for comb honey. Such supers fully equipped can be purchased from the supply dealers.

The Honey Board:—This term is variously and wrongly applied, but should be given to a flat board that is placed on top of the super to cover it entirely and keep the bees down. This provides a bee space between the honey and the honey board which is not provided by an enameled cloth or oil cloth. It is particularly used on those hives where the cover is of a telescopic nature and fits over the sides of the hives to some extent. Without the honey board the cover would drop on bees crawling over the upper edge of the super or hive, and would crush them, as it is impossible to put a telescopic cover in place by sliding it from one side, as the flat covers. Thus with a cover of this kind the honey board is an important accessory.

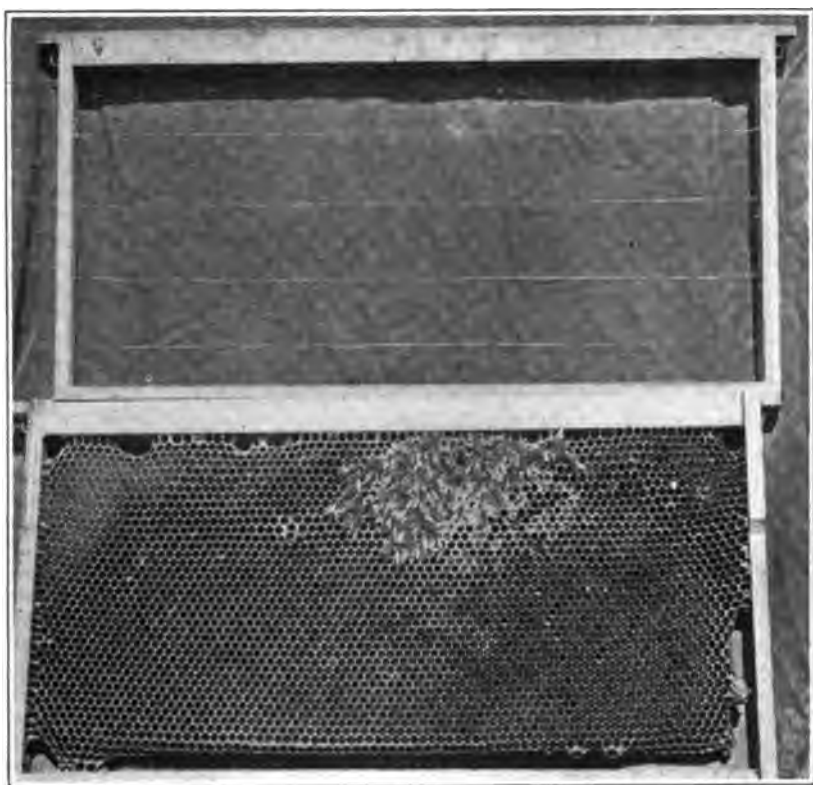
(h) *The Smoker:*—No bee-keeper attempts to keep and handle bees without a smoker, any more than a man attempts to drive his horse without lines. It is true that some persons can,—and occasionally do,—open the hive without the use of the smoker, but the rationally careful bee-keeper is always equipped with a lighted smoker close at hand, ready for emergency. When the day is fair, and nectar in abundance is coming in, the bees may be very mild in their nature, and safe to handle without a smoker or veil; but under certain conditions, such as the sudden approach of a thunder storm, the entire nature of the colony may change in a half hour from that of tranquility to that of turmoil. They may become angry and even drive the operator from the yard. To be a bee-keeper requires not only a knowledge of the subject, but considerable courage and determination. The man who works with bees must not object to being stung occasionally, and the beginner can console himself with the fact that he will soon become so immune from the effects of stings that these will not be as enduring nor as irritating as the bites of mosquitoes. He must never expect that he will be able to do much work with bees without being stung, but he can feel sure that he will gradually become so immune to the stings that he will not be bothered by them, and he will further learn that "discretion is the better part of valor," and when under certain circumstances the colony becomes aroused to a real battle he must withdraw as



No. 12. Dove-tailed Hive. At the left is a ten-frame hive with staple spaced frames; at the right is a eight-frame hive with self spaced frame and the follower partly raised.



No. 13. (above) Frame with wire foundation. Cells slightly built out toward the right.
(below) Frame with drawn comb. The bulk of the larger cells is drone comb, and the remaining part worker comb.

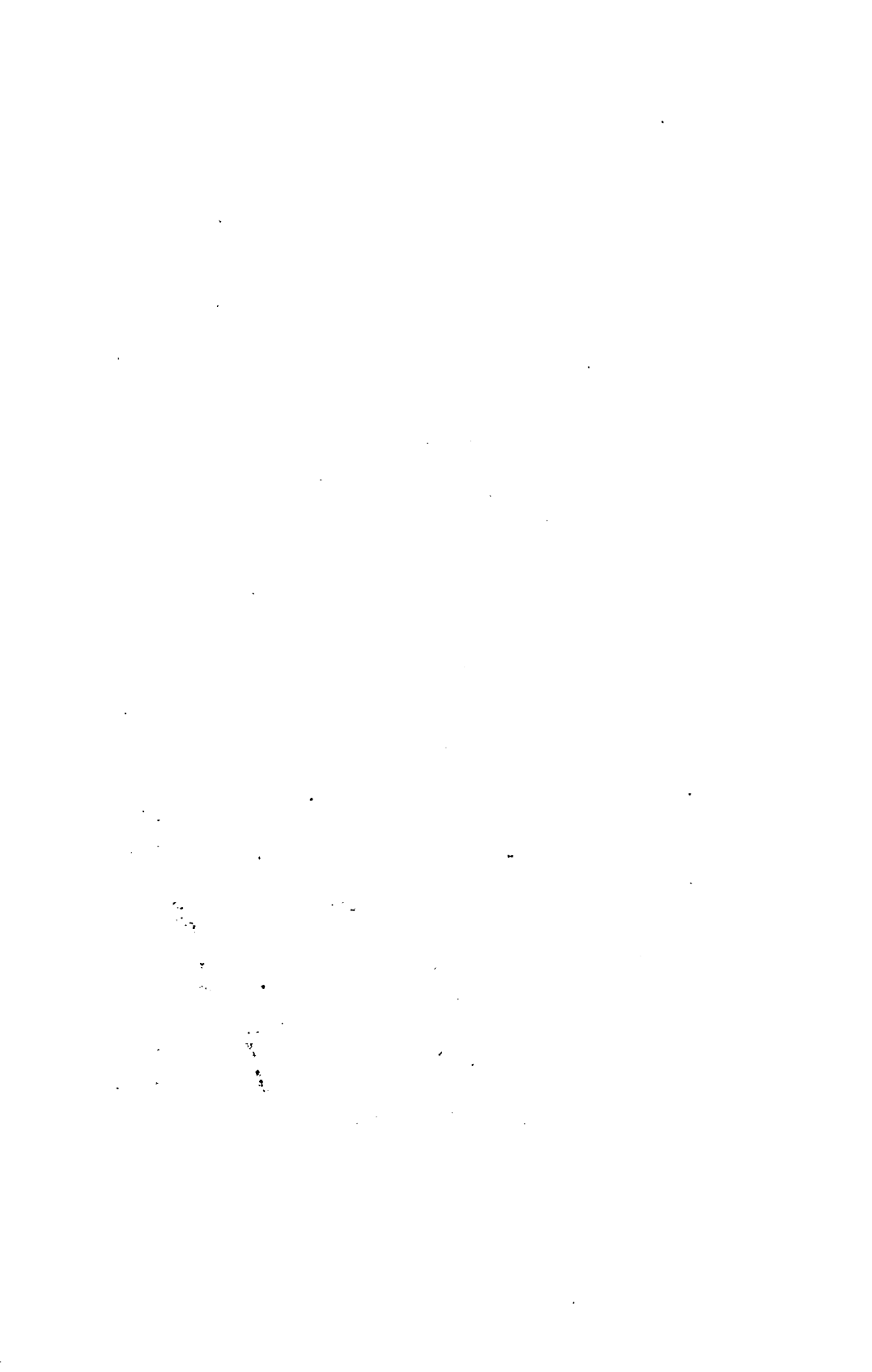


No. 14. (above) Frame wired, but otherwise empty. Correct methods of stapling shown by this frame.

(below) Frame with comb and dead bees, which starved to death by being in an over-populous colony. Along the lower margin are queen cups, while just above the lower right corner is queen cell from which a queen emerged.



No. 15. Pointing Out Queen.





No. 16. Clipping the queen's wings with a penknife.





No. 17. Frame of drone combe made by patching together several small pieces of drone comb from different hives.



No. 18. Splitting away the side of an old box hive to begin transferring.

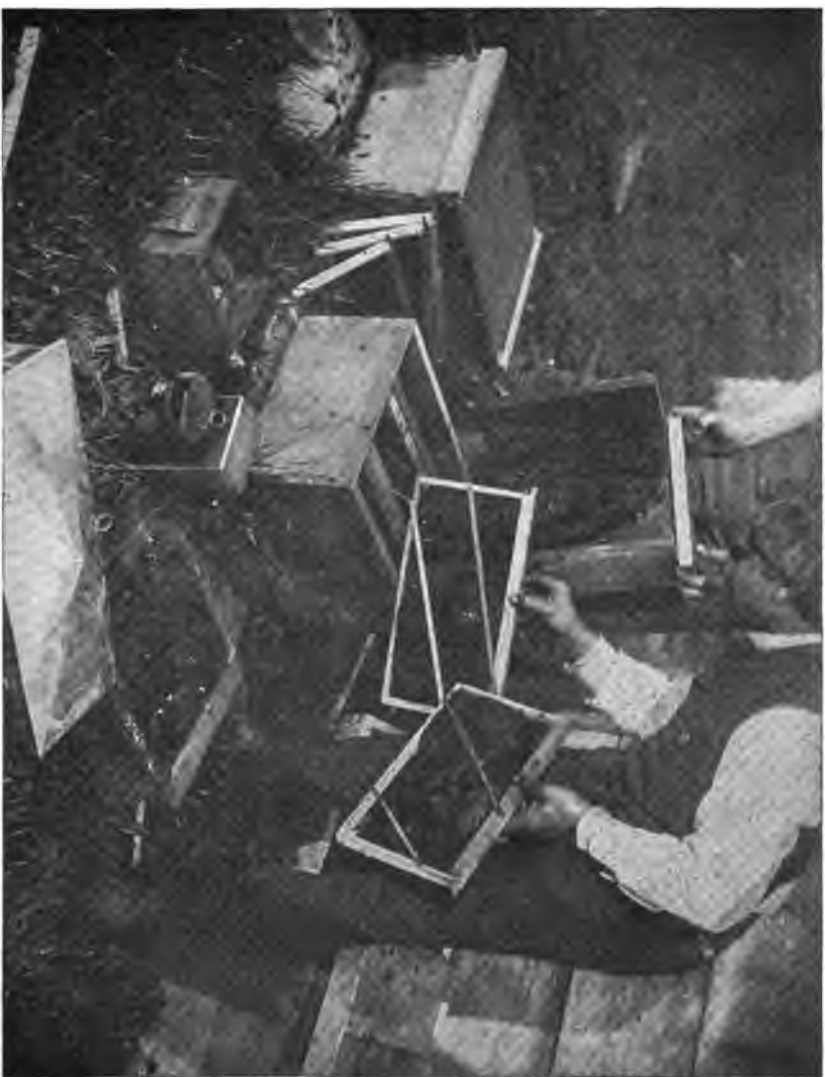


Figure 4. The relationship between the number of species and the number of individuals for 1000 random samples. The number of species is plotted against the number of individuals for 1000 random samples. The number of species is plotted against the number of individuals for 1000 random samples.

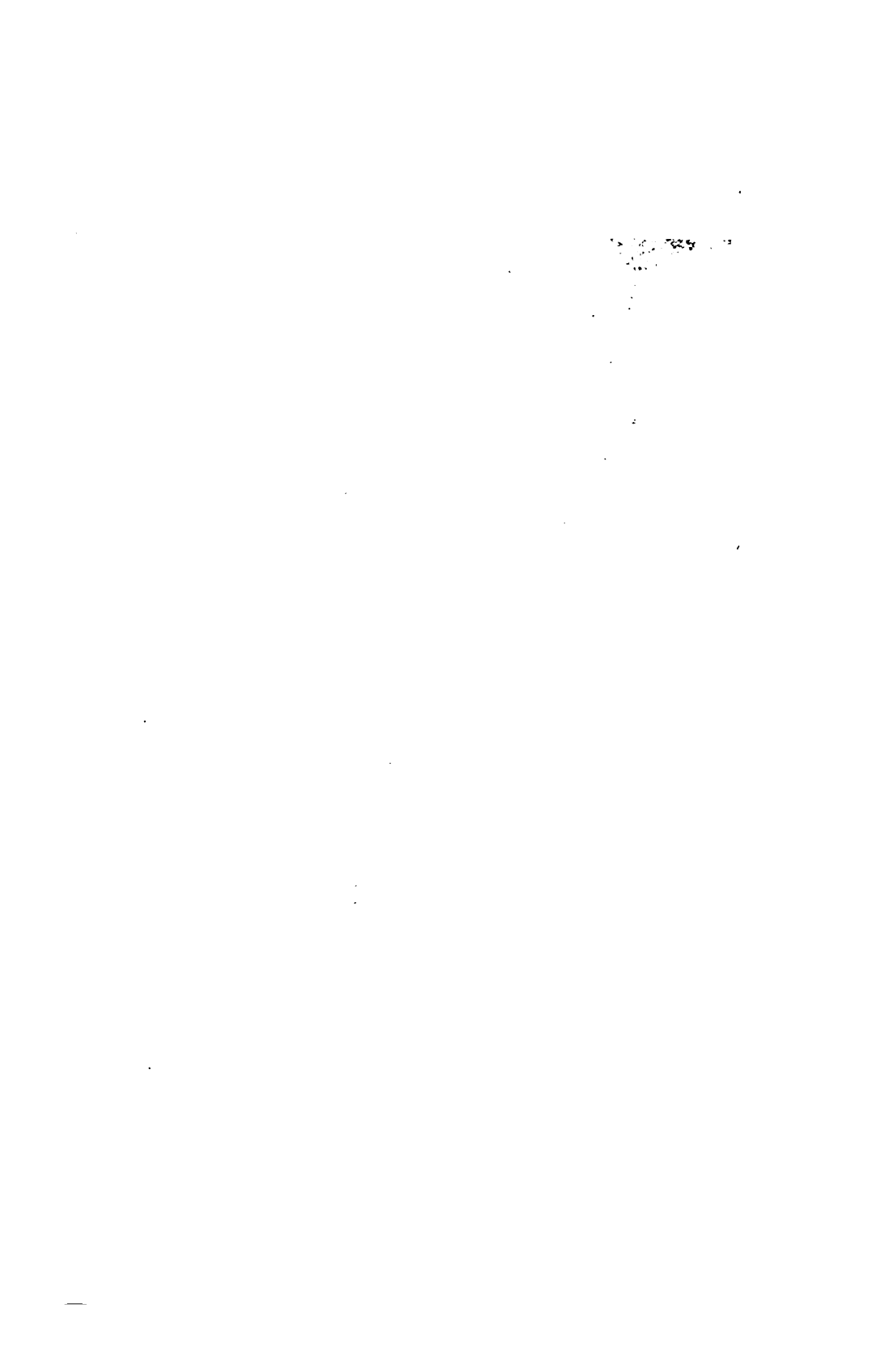


No. 19. Fastening comb into frame as it is cut from the old hives.





No. 20. Placing into a new hive frames just filled with comb and brood, and shaking bees into the same.



gracefully as possible, and permit the bees to remain in possession until they are in better mood to be handled.

When a person is stung the best thing to do is to remove the stinger, not by catching hold of it and squeezing it, for this forces the poison from the poison sack deeper into the wound in the flesh, but it should be removed by rubbing or brushing it sidewise. The sooner it is removed after it is in its victim the less poison will be injected, and the less will be the injury, as it continues to inject poison into the wound for sometime after it has been inserted by the bee. One who is accustomed to working with bees will remove the stinger with a quick slap the instant he feels it inserted. One can tell by experience whether the bee is angry and intending to sting, and if there are only two or three cross bees he can kill them by knocking them helpless, but not by crushing. Also he can tell by the way the bee lights on him whether it is merely resting or preparing to sting. In the former case he will let it rest in peace, but in the latter he will, in most cases, be able to knock it away before it can carry out its purpose.

The Cold Blast smoker, with an upright bellows like the Cornell or the Danzenbaker, is best. The first step toward working with the bees is to see that the smoker is well lighted and provided with fuel which will make a lasting or smouldering fire. For this purpose dry rotten wood is best. One should go into the woods and select some pieces of rotten logs or stumps, and keep them in his bee house for smoker fuel. Broken sticks from dead twigs, or anything that will burn, will serve his purpose in emergency.

He should be careful to avoid burning the bees. What he needs is smoke instead of heat. If his fuel should burn too fast and give too much heat he can check this by crowding some green leaves or grass into the top of his smoker over the fuel.

The operator should remember that it is cruel to smoke the bees any more than is necessary, and that he is losing honey and money by so doing. Every time the hive is smoked it demoralizes the bees and throws them out of normal action, and consequently reduces the amount of honey they are producing during the period of time it is required for them to get back into their normal condition. Thus there is a really financial objection to working over the bees a great deal of the time, as much loss can come from this, particularly during the honey season.

(i) *The Veil*:—The bee veil can be any kind of material that will permit the wearer to see through it clearly, and at the same time give him protection and ventilation. A good veil is made by cutting a strip of wire screen material about a foot wide and three feet long, bending this in the form of a band, and around each edge sewing bands of muslin. The cloth at the upper edge can be provided with

a rubber band to partially close it, or draw it tightly over the hat, while the free side of the band of muslin around the lower edge can be provided with strings to fasten around the waist, or can be tucked beneath the coat, or otherwise closed to prevent the bees from getting under it. Regular bee veils are sold by dealers in supplies. A good veil can be made with ordinary mosquito netting by using either black netting or coloring the white netting with black dye.

While it is possible for an experienced person to work in his bee yard without a veil, it is not safe to be without one within reach. Owing to the bees becoming suddenly angry or infuriated, and the possible evil consequences of this, the smoker should always be lighted, and the veil convenient. Beginners should wear not only veils but gloves. After they become more experienced they will reduce their gloves to mitts by cutting out the finger coverings, and thus facilitating better handling of hives and frames. Afterward they may prefer to use merely rubber bands snapped around the sleeves to prevent the bees from crawling up. Most experienced bee-keepers work without gloves, but find rubber bands around the sleeves and trousers decidedly advisable.

(j) *The Hive Tool*.—For opening the hive and separating the frame some kind of a heavy tool is needed. A good strong small hand trowel is suited to this purpose, but most dealers sell a small implement especially made for the purpose, provided with an edge for inserting into the corner beneath a cover or super, for raising it by prying, as with a lever. A good hive tool is provided with a sharp edge for scraping off propolis or bee glue, burr comb, and other undesired substances. Two small hooks, to help in lifting frames, may be useful.

(k) *Sections*.—The little boxes placed in supers for the bees to use in storing comb honey are called "Sections." They are variously made, and consequently have different descriptive terms, according to their varying forms. Those made of four pieces, fastened together at the ends, which become the corners, are called "four-piece sections," and those made of one piece of wood, grooved where this is to be bent to form each corner, are called "one-piece sections." The latter are much more generally in use. It is necessary for the bee-keeper to decide what style and size sections he will use before ordering his hives and supers. It then becomes only necessary for him to name the number and style of frames that he wishes, and select the kind of bottom board and cover, and the manufacturer is able to send him the entire outfit complete. The size and equipment of the super depend upon the size and style of sections or frames to be used.

A plain section is one with straight sides, which does not have a space or "bee way" cut into it for the bees to pass through. Such

sections are kept apart and the bee spaces are provided by means of little separators commonly called "gates." These plain sections are generally narrower than the "bee-way sections," which are so named from the space cut into them. If they are opened on only one side, for example, it would then be the under side only, and they are called "one bee-way sections." They are variously known as two bee-way, three bee-way and four bee-way, respectively, as they are open at two, three or four sides. To promote ventilation, the four bee-way section is most desirable among sections of this style, but the plain section, with gates, is doubtless best.

As to shape, the section may be square, and it is then generally made with sides of four and a quarter inches, or it may be rectangular. Without discussing in full the various forms or types of sections, we can say that we have tried different kinds and are well satisfied that for the production of comb honey for the market the most desirable section is the plain section, five inches high, four inches wide, and one inch thick. Honey produced in this is neat in appearance. The comb is thin and it looks very clear.

The sections rest in little frames called "section holders" and are held firmly together by springs or clamps. The number of sections in each super depends upon their width and thickness, or in other words, upon the style of each used. In ordering modern hives it is not necessary to go into further detail than to order supers equipped for holding "plain sections 4x5x1 inch," or such other form as the honey producer may prefer. The chief object of the producer of comb honey should be to obtain sections of just one pound each of good, well-capped, clear, white honey. Separators between the sections help to prevent the bulging of one section by over-filling and the dwarfing of another by the space at its side having been taken by the former.

(l) *Queen Excluders*.—The Queen Excluder is a sheet made either of metal, or of wood alternating with metal, containing spaces of such an exact size as to permit the workers to pass through, while the queens and drones cannot. It is not needed in running an apiary for comb honey, but in producing extracted honey, it should be used between the brood chamber and the super to keep the queen down in the former. It may be made of sheet zinc with punched holes of exact size, or it may be made of small wire rods and wooden supports to hold the rods exact distances apart. We prefer the latter style, as it evidently does not wear the wings of the workers in passing through as much as do the sharp edges of the punched zinc.

(m) *Enameled Cloth*.—A sheet of enameled cloth or oil cloth is often used in the inside of the hive over the top sections or frames in order to retain heat and keep down and protect the bees. This is cut just large enough to fit the inside of the super or hive and is put in place before the lid is put on.

(n) *Bee Escapes and Bee Escape Boards*:—The bee escape is a contrivance arranged like a valve which lets a substance pass one way and closes when it starts to return. Such a contrivance is made and used to let bees out of one part of the hive, or out of an enclosure, and prevent their returning. It can be used in the windows of honey houses to let out bees from the inside and prevent the ingress of those that are without. The most common and important use of the bee escape is in a board called the "bee escape board," placed immediately beneath the filled super which is to be removed when honey is taken. In using this device it is important for the circular side escape to be placed toward the bees that are to pass out. When the board containing such an escape is properly placed between super and hive, or between one super and another, and just a little smoke puffed over the bees above, they will quickly work their way down through the escape, and the honey-bearing super can be lifted off without causing a disturbance in the hive, such as sometimes ensues when it is robbed. It is a good plan to place the bee escape board in position in the evening and find the super cleared of bees the next morning.

(o) *Hill's Device*:—This is an arrangement of small curved pieces of wood, held together in such a way that they can be laid over the tops of the frames and leave a space within the arc of their circle where the bees can pass from one frame to another. It is used in wintering, for the purpose of holding the cushion clear above the central frames and making it possible for the bees to get from one part of the hive to another without having to go around the ends of the frames.

(p) *Chaff Cushion*:—This is also used in wintering bees and is placed over the Hill's device for the two important purposes of absorbing moisture and retaining heat. It should be about the size and shape of the interior of the hive or super, or a little larger. It is a bag of any kind of cloth filled with chaff or of finely chopped hay or cut cork (clean clover leaf chaff is best) and placed in an empty super over the Hill's device when the bees are prepared for winter.

(q) *The Extractor*:—Extracted honey is sure to become more popular than comb honey for home use and as a market product. This is because of its more desirable and convenient form for table use and also its cheaper production. It has been estimated, and doubtless correctly, that a person can produce three times as much extract honey in the same season and from the same bees as he can of comb honey. It is very evident that if the bees must use time and honey in making comb they cannot store as much honey during a comparatively short nectar flow as though they were industriously engaged at the sole occupation of gathering nectar at this period and storing it in combs ready to receive it.

The extractor is a machine for holding the frames of combs while they are revolved rapidly and the liquid honey is thrown from them by centrifugal force. The honey is first uncapped by a knife, known as an uncapping knife, which is kept heated generally by dipping it into hot water, and which then can be used deftly to slice the cappings from the combs. A little experience will enable any one to use the extractor in a satisfactory manner. Experience will also teach the operator that he must keep all honey away from prowling bees if he would prevent robbing and the furor that may come from carelessness in this regard. The importance of ripening extracted honey, or (better) of extracting only ripened honey, must be remembered.

METHODS OF MANIPULATION.

With the knowledge of bees and of needed equipment explained in the foregoing pages it remains for the bee-keeper to practice those methods which will lead to the best results. It must be remembered that there is no special value whatever in a modern frame hive if it is used only the same as an ordinary box hive. The value of apparatus consists chiefly in its proper use.

To Open, Examine, and Close the Hive:—After having provided the smoker, adjusted the veil, and having placed rubber bands around the sleeves at the wrists and trousers at the ankles, the keeper is prepared to open his hive. He must remember that a little smoke is needed to control the bees, but he should not use any more than is necessary. Elsewhere in this bulletin are discussed the objections to too much smoke. A puff of smoke should be blown into the entrance of the hive and the cover raised enough to permit a little smoke to be blown over the frames. If the enameled cloth is present, this should be turned back and a slight puff of smoke blown over the bees that are exposed. If the super is on the hive it is not necessary to remove the enameled cloth and cover, but by use of the hive tool or chisel inserted at a corner between the super and hive body the former can be raised enough to permit a little smoke to be blown into the crack between them, when the super can be set to one side and the operator can proceed to lift out the frames of the brood chamber and examine them. During the manipulation he should stand or sit at one side of the hive,—never in front of it.

Sometimes a hive (especially the eight-frame) is provided with a small thin, hanging board at one side, sometimes wrongly called a "division board," but more correctly termed a "starting board." Where such small board is present at the side of the hive, the first move of the operator should be to loosen it by prying gently with the hive tool and then lifting it out. Next, each frame should be loosened by prying sidewise with the hive tool just enough to loosen

it, but this should be done gently. Suddenly jarring the hive or jerking the frames will cause the bees to rush out and start an attack which may prove serious. As the frames are loosened they can be drawn toward the side of the hive, or, if there is no starting board, the outer frame can be lifted out, thus making room to loosen the others. The proper way to lift the frame from the hive is to grasp it either at the exact center with one hand or at the two ends with both hands.

In turning a frame to look for a queen it is best to use both hands and learn to turn it by a method that will insure against a new, soft, honey-laden comb dropping suddenly from the frame. Of course where whole sheets of wired foundation are used this is not liable to occur, but it does so frequently occur that every person should remember to manipulate and handle a frame in the proper manner. This is as follows: Hold the frame horizontal in both hands by each end of the top bar; turn it on end by swinging the right hand vertically over the left; then swing the frame around as one would swing a door on its hinges, so that the opposite side is brought into view while it is yet standing on end, with the left hand supporting the lower end of the top bar and the right hand holding the upper end. Then bring the right hand down to a level with the left hand thus holding the frame entirely up-side-down and horizontal, by having turned it on end rather than sidewise. This makes it possible to examine both sides without the dangers mentioned above. To return it to its former position and to the hive, reverse the operations by swinging the right hand vertically above the left, turning the frame half way around the top bar by swinging it from the operator like a door upon its hinges, and bringing the right hand again to a level with the left, when it is again right side up and horizontal, and ready to insert in its place.

In hive manipulation great care should be taken that the queen is not crushed nor dropped from the hive. Stapling both the sides and ends of frames, at both the top bars and bottom bars, will give bee-spaces which cannot be closed by the frames swinging together, and which will prevent crushing the queen and other bees in this manipulation. Holding the frames always directly over the hives in examining them will insure against the queen falling outside the hive if she should drop from them.

When it is time to close the hive see that the frames are spaced at equal and proper distances without severely disarranging the brood nest. It is possible, when the weather is warm enough and food is coming in, to enlarge the brood nest artificially by removing one of the side frames of the brood chamber and inserting a frame with drawing comb or foundation in the midst of the brood nest. If a frame of drawn comb is used it will in most cases be layed full of

eggs during the night. If this is a good strong colony a frame of sealed brood can be withdrawn and removed to a weaker colony. This will strengthen the latter without giving them the additional burden of having to gather food and devote their energy to rearing young.

During the season when the bees need food a frame containing thick syrup poured into the cells, or one of honey, can be inserted into the middle of the brood chamber and the bees will soon take it up and place it where they want it.

In closing a hive, the enameled cloth should be put in place over the frames and the honey board or cover should be replaced by sliding it on from one side rather than by dropping it on, thus avoiding crushing the bees. If a super is in use it should be placed over the hive body by sliding it in place instead of by setting it down directly where the bees are crawling. If there are any bees in the way they can easily be driven away by the use of a little smoke.

TRANSFERRING.

By this is meant changing the bees, with their comb, brood and honey, to a modern frame hive. If bees are obtained in some other kind of hive or container it is best to keep them in this until there is a natural nectar flow, but see that they are well fed and protected. At about the beginning of such period is a desirable time to make the change. The best time in the entire year is during the apple blossom season.

To transfer a colony of bees it is best to knock the bottom from the old hive, and turn it upside down, after properly smoking it, and fasten over it a box of such size and shape as to fit it all around. This can be fastened by a few strips of wood and small nails. Next smoke the bees slightly through the hole that is in the lower part of the old hive as it now stands, and pound on the sides of the latter by tapping it with a hammer held in each hand. By continuing the pounding on the sides of the old hive, the bees will be driven upward into the box above. The operator can know when the queen is up by the humming sound showing that most of the bees are in the upper box. It is possible to drive by far the greater number of them up and out of the way. When this occurs lift off the box gently, and set it at one side on some sticks to raise it slightly. Shake or jar the old hive in front of it, and jar or shake out as many bees as possible, being reasonably sure that the queen has gone into the box that was set aside. This is to provide against her destruction in handling the combs.

Next split away one side of the hive that is parallel with the honey combs with cold chisel and hammer; and if there are cross sticks

in the hive saw the ends of these close to the inner sides of the box. The outer comb may contain nothing but honey, and can be cut out and laid aside. It is not worth while to attempt to save and transfer any but the combs containing eggs or brood. As soon as such is found brush the bees from it and lay it into a frame lying on a board a little larger than the frame itself. In fitting the comb into the frame it can be placed in any position excepting directly upside down. That is to say, it can occupy the same position that it did in the hive, or it can be turned half way around in either direction.

Next, tack across the comb thin strips of wood, like the wooden wedge strips that are made for fastening foundation in frames. By a tack in the bottom bar and one in the top bar such strips can soon be fastened in place, so that the comb will be held firmly in position from this side. Some persons use string wound tightly around the frame to hold the comb until the bees fasten it. Strong rubber bands may serve the purpose, but after considerable experience we prefer slender wooden strips.

After the upper side is fastened lay another small board over the frame, and by placing one hand under the lower board and the other hand over the upper board, turn it completely over. In this way the side of the comb that was below is brought above without removing it from the frame and can now be fastened in place.

Next set this frame in place in the new hive, which should be near at hand to receive the frames of comb with brood and eggs, as they are prepared. Cut out other combs from the hive and fasten them in the frames, and set them in the new hive. By keeping the cover partly over the hive bees clinging to combs can be shaken or brushed into it. After the transferring of comb and brood is completed, the new hive, with bottom board and cover in proper position can be set upon its stand, and the bees in the box can be shaken in front of it. It may be a good plan to give them a few frames of drawn comb or of wired sheets of foundation, or if the weather be warm, place an empty super over the hive to provide for ventilation at this time when they are agitated and unusually heated.

They will not desert the frames with brood, but will at once fasten the combs in place, and as soon as this is done the wooden strips can be removed by prying them off. Now as the bees are in movable frames it is an easy matter to lift these out, one at a time, and find the queen and clip her wing. The honey that was removed from the old hive can be used on the table, or can be reserved for further feeding the bees or fed back to them at once. If the operator should wish he can transfer to the new hive nearly all the honey in its comb, together with the brood.

It is decidedly not best to attempt transferring when the combs in the new hive are full of freshly placed, thin honey, or when there are soft, newly-built combs in the hive. It is difficult to make these

new combs stand in frames, and when combs are found that are unusually wide and filled with honey it is best to cut them out instead of trying to fit them into frames. Where the combs are crooked they can be cut at one side and partly straightened, and where necessary it is even possible to cut the combs into small pieces and fit several of these into one frame. Transferring and other working with bees that results in exposing honey should never be done during such a period of scarcity as will start robbing. Therefore, after the honey flow has ceased is particularly a wrong time to transfer bees. By all means the best time is just at the beginning of the first nectar flow, or in apple blossom time.

It is really enough, if done during the nectar flow, to remove a frame of brood from another hive to the new hive to which the colony is to be transferred, and fill this up with either drawn combs or full sheets of wired foundation, and then drive or shake the bees from the old hive into this. With a few frames of drawn comb, and nectar flowing in abundance, the entire colony, including the queen, will get to work like a new swarm, and will soon fill the hive with a strong colony and with combs really far better than those that can be obtained by transferring crooked, irregular or fragmentary combs from the old hive. At the same time the operator has the combs from the old hive to use in making beeswax, and the honey to eat, or feed back to the bees, as he may choose.

RE-QUEENING.

The question is often asked as to how frequently a colony should be re-queened. This depends to some extent upon the old queen. Some persons say it should be done once every year, but if the old queen has proven good and active, maintaining a populous colony, it may not be necessary to re-queen oftener than once in two years. It often occurs that a queen does not commence to deteriorate perceptibly within two years.

When to Re-Queen:—The time of year for re-queening is to be considered. This depends upon conditions. One rule can be laid down as fundamentally important, and that is that *whenever a colony becomes queenless, from any cause, it should be re-queened just as soon as possible thereafter.* If queens are to be obtained from other apiaries it is a good plan to procure them fairly early in the season, and use their progeny for rearing new queens. Many persons re-queen just at the beginning of the white clover flow, and thus avoid many swarms, as a colony with a new queen is not so liable to swarm as that with an old queen. In general practice, it is best for beekeepers to produce most of their own queens, from extra select

colonies, and re-queen at least by the time of the close of the principal honey flow.

How to Re-Queen.—A colony can be re-queened by giving it either a ripe queen cell or a queen. By "ripe queen" cell is meant a cell from which the queen is about ready to emerge. When a good colony is found to contain queen cells, in good condition for transferring, the undesirable queen can be removed from her colony, and at once the queen cell can be set in place in a depression in the comb.

In re-queening with a queen it may be necessary to introduce her with an introducing cage. At present most queen mailing cages are made for the purpose of introducing the queen into the hive in the same cage in which she was mailed. Full directions are generally printed on the cage. Such a cage is provided with candy which must be eaten away by the bees before they reach the queen, and thus they become accustomed to her and do not attack her.

There are several means of quick introduction of queens, such as dusting them with flour, dipping them in honey, sprinkling the colony with very dilute peppermint water or other material, that the odor of the newly introduced queen will not be recognized. In many cases the new queen can be introduced directly by putting her into the hive within two days from the time the former queen has been removed. Also, sometimes a wire cage is used that keeps her enclosed for a day or two, after which she can be released among the bees.

"SHAKING."

By the term "shaking" is meant shaking the bees from the frames in front of the hives. It has been believed that the stirring up, such as is produced by this process, makes the bees much more active or vigorous, and theoretically it should result in greater honey production. Of course, when there are no flowers in bloom to yield nectar it can not have better results in this regard, but the reverse may be true, as it may increase honey consumption, and thus reduce that which is in the hive.

In shaking, the bees are merely shaken on a cloth in front of the hive, from the frames, one frame at a time in rapid succession. If done with care in regard to the queen she will not be injured. The frames are returned to the hive, sometimes in positions different from those which they formerly occupied. This shifting of the frames and the brood nest helps to give the bees some renewed activity but in cool weather should be avoided. If the bees are loafing at the time when they should be bringing in honey, they should be well shaken and more room in the brood nest given by the removal of some frames filled with honey, and the introduction of some with drawn comb in

the middle of the nest. Also greater ventilation should be given the hive, when the loafing will cease. By "loafing" is meant hanging out in great clusters at the entrance of the hive, or beneath it.

How to Use Foundation:—Foundation is of two kinds: (a) Super-foundation, which is white and thin, for sections of comb honey; and (b) brood foundation, which is yellow and heavier, for frames. Both are sold in three grades, according to weight. The medium grade of each is mostly used. Both are used either as full sheets or as narrow strips, called "starters," because when such strips are used the bees start their comb evenly by means of them. In both sections and frames it is generally better to use full sheets of foundation, although if this is not done strips as starters are recommended.

To Fasten Foundation in Sections:—Super foundation is fastened in sections after cutting it just wide enough to fit the inside width of the section snugly without crowding. It can be used as a "starter" but two cells or more deep, or in full sheets as long as the entire inner length of the section. Full length strips or sheets aid in producing more fully completed sections, without bee holes in the corners.

The best plan is to use in each section a sheet lacking three or four cells of the full length, and then set little strips of starter in the bottom not more than two cell spaces high, so that it will almost meet the suspended sheet hanging from above. This insures sections of comb built entirely to the bottom and nicely filled.

For fastening the foundation in the sections several forms of a device can be had, called "section foundation fasteners." Directions for manipulation can be obtained with them. It is also possible to fasten foundation or starter by pressing it with a dull iron edge firmly against the wood of the section at the place where it is to be held. Another means is to use just enough melted resin and bees-wax (equal parts) to fasten the edge of the section to the wood when it is held in position with the section inverted. It is best to use a foundation fastener.

To Fasten Foundation in Frames:—Most frames are made with a groove in the under side of the top bar to receive the foundation. After a frame has been wired it should be turned upside down, and a full sheet of foundation inserted into the proper groove for it, and fastened in place either by the long wedge-shaped wooden strip provided for the purpose, or by running a line of melted resin and bees-wax along its edge. The wedged-shaped, wooden fastener should be set into the groove opposite the thin wooden tongue of the frame which rests against the foundation, and is effective if the wedge be pressed firmly into position. While full sheets of foundation are more economical in the end, if the operator should wish to use only strips of starters in the frames, he can do this, fastening them as directed for full sheets, or by merely pressing them firmly against the underside of the wooden top bar.

How to Fold Sections:—Most of the sections that are purchased with modern hives and supers are in single strips of wood, grooved at the places that are to become corners. These should be turned with the grooved side downward, and the thin wood opposite the groove should be moistened with a cloth dipped in warm water. By simply brushing a damp cloth against the side opposite each groove, and laying the extended section aside for a few minutes, the fibers become sufficiently softened to make it possible to fold it together by hand and drive the dove-tailed corners into position by tapping with a light hammer. A section-folder can be used, but is not essential.

How to Wire a Frame:—All brood frames and extracting frames of standard size or larger should be wired for the purpose of holding the foundation and comb firmly in position during manipulation or extracting. This consists in stretching across the frame a fine wire, which is to be imbedded in the foundation to hold it in place. Wire of proper size and kind for this purpose can be purchased by the spool of all dealers in supplies for bee-keepers. It is possible to buy frames with end bars perforated ready to receive the wires. In fact, they are generally sent perforated, unless otherwise directed.

The frame is wired by fastening one end of the wire to a tack or the upper staple, and carrying the wire back and forth in a horizontal position, first through a hole in one end bar, and then in the other, until the frame is filled. It then generally contains four stretches of wire, which should be drawn fairly tightly and fastened in position by wrapping around a very small tack driven for the purpose. If the wires are not stretched fairly tightly they will permit the foundation to sag, and this may cause drone comb formation.

How to Imbed Wire in Foundation:—After wiring the frame and inserting the foundation in place it is necessary to imbed the wire in the foundation in order that it will be effective and serve the purpose for which it is intended. This is best done by cutting a board, just to fit the inside of the frame, and after the foundation has been put in place in the wired frame, lay it over this board in such a manner that the sheet of foundation is between the wire and the board with the wire above. With a small marking wheel on a handle like a tracing wheel, called the "imbedder," made and sold by supply dealers, the operator should run along the length of each wire, pressing just firmly enough to imbed it well into the wax foundation, but not enough to cause the wire to cut the wax into strips.

CAUSES OF FAILURE IN WINTERING.

The season that is hardest on the bees is that of the winter time. More colonies are lost at this season than at any other, and as much

of this loss is avoidable, the bee-keeper should make a study of the methods of wintering, and the causes of failure at this season.

In colder regions bees are wintered either in trenches or in cellars. Trenching consist in digging trenches in the ground, setting the hives therein, and covering them over with straw and earth, as we cover cabbage or apples in the garden. In cellaring, or wintering in cellars, the bees are carried into cellars after the freezing weather has commenced, and are there stacked up, with the bottom boards removed from the hives, or with the deeper side of the bottom board upward, and the entrance left open for ventilation. Each is provided with a chaff cushion, in the empty super above the brood chamber, to absorb moisture. About once every six or eight weeks they should be taken out doors and given an opportunity for cleansing flight, as they are known normally to cleanse themselves only when flying. This is, of course, should be only during warm, bright, sunshiny days.

Recent experience has proven that cellar wintering is not as essential in this State as was formerly thought, even when the temperature reaches thirty or thirty-five degrees below zero. The main points in wintering are to have plenty of good sealed stores for a good number of young bees, and to give them some ventilation and some degree of protection from cold windy blasts. Double-walled hives may be some aid, but they are not at all necessary. The protection of the hive should consist of boards, or corn fodder, or a shed, around it to prevent the cold wind from striking it.

Outside wintering boxes are helpful by placing the hives in them, and arranging some protecting material, like leaves or chaff, between the outside box and the hive, on the principle of the double-walled hive. It is very important for this to be kept dry, and for an opening to be made for the bees to go in and out of the hive for flight during nice days of winter.

Among the cause of failure in wintering are the following:

1. Insufficient amount of sealed stores or food. There should be at least thirty pounds of sealed food besides, the weight of the bees and the hive. (See discussion of "Feeding").

2. Stores unfit for bee food in winter. This food should be (1) good pure syrup, such as is made by dissolving granulated sugar in water, or (2) bee candy, or (3) pure honey. Dark honey is as good as white for wintering purposes, but honey dew honey is unfit for this purpose and may give the bees dysentery. Soured honey is unfit for wintering. It can be kept for stimulative feeding in the spring when the bees are flying, and will be all right to use then if not too badly spoiled. If the bees run out of stores in very severe weather, when they should not be disturbed, dry bee candy can be given over the frames with good results. This is described elsewhere in this Bulletin.

3. Dampness in the hive. This is fatal to the bees. It is best overcome by being sure that the hive slopes from the rear to the front, and that there is an abundance of front ventilation and a dry chaff cushion in the empty super over the frames which should contain only sealed stores. Bees should never be stored in damp cellars nor be surrounded with wet packing material.

4. Lack of ventilation. It does not hurt the bees to get some cold air into the hive, if it is good pure air. The opening can be as wide as the entire entrance of the hive, but merely high enough to prevent the entrance of mice, which should not be more than one bee space. A deep bottom board is often used for wintering, as it permits dead bees to drop down beneath the frames without clogging them. This is highly recommended. In every populous city there are some deaths, and it is, therefore, not surprising that many of the old bees die during the winter time and are to be found on the bottom board beneath the frames, especially when it is remembered that there are from thirty thousand to fifty thousand bees wintered in the colony. As they die and fall on the bottom board their remains are liable to clog the frames and prevent ventilation, unless the deeper bottom board is used.

5. Mice in the hive. Where mice enter the hive they destroy the comb and brood, and even the bees themselves. They befoul the hive, and play havoc with it in general. To prevent this the opening should be narrowed to one bee space, or it can be closed with wire netting. If the wire netting is used, however, it should not be forgotten during nice days when the bees need flight, and should then be temporarily removed. The best method is to keep out mice by using galvanized wire netting with three meshes to the inch.

6. Lack of young bees. That colony of bees which goes into winter with great numbers of young bees, an abundance of stores of the right kind, and the proper ventilation, will be practically certain to come out all right in the spring. Old bees are much less liable to winter well. For this reason stimulative feeding in the fall is of value to insure the rearing of young bees, and is commendable. The young bees which matured in the latter part of fall will be the good, vigorous workers to build up the colony in the spring and prevent spring dwindling.

7. Too many bees. Strange to say, there may be too many bees in a hive for successful wintering. This is where the hive is small, as in the eight-frame hive, and the colony boiling over with an unusually large population. We have seen unusually populous colonies, well filled with honey in the fall, consume all their food during the winter, and be found dead from starvation upon opening in the spring. It would be better to reduce the size of such an extremely large colony by shaking some of the bees into a weaker colony. If

this is not done they should be transferred to a larger hive and given an abundance of food.

8. Hive too small. The eight-frame hive is too small to hold enough food and enough bees and enough heat to be sure of wintering well out-of-doors without special protection. When wintering out-of-doors more food is needed than when wintering in the cellar. If one is obliged to attempt to winter in an eight-frame hive it may be better to place the bees in the cellar, but the ten-frame single-walled hive, if slightly protected (as described above), and well supplied with food, will surely give good results for out-door wintering anywhere in this State.

9. Exposure. It must not be supposed that bees will always winter successfully in single-walled hives outdoors without some special protection. This is easily provided in the form of an outer box, a shed, boards, corn fodder, or otherwise.

Snow over the hive need cause no alarm, but snow and ice clogging the entrance may cause destruction and should be removed. When wintering out-of-doors, it is especially important for the hive to be inclined forward for the water to drain out instead of in.

10. Bee Diseases. A colony may appear to be in good condition when going into the winter, but if attacked with bee diseases, such as foul brood, it may dwindle away, and continue to become worthless and finally perish. (Send to this office samples of brood in comb suspected of being diseased).

SPRING DWINDLING.

The term "Spring Dwindling" is given to the gradual weakening of a colony in the spring time. This is due chiefly to the bees of a weak colony starting to fly too early or to the old bees of the colony dying. When the ground is very cold or covered with snow the bees may come forth from the hive in a warm atmosphere and prepare to fly, but as they light upon a cold object they become chilled and stiffen and unable to return to the hive. If a colony is supplied with sufficient food and water, and kept warm but protected from the too early warming influence of the sun, as well as from the wind, the bees will remain in the colony until time for them to fly forth safely. It is well to cover the hive with black paper in the early spring. In some cases pollen is needed in the hive, and a fair substitute for it will be found in pea flour or rye flour, a little of which can be sifted over the frames, and thus meet the needs of the colony for brood-rearing at this time.

Spring Dwindling is worse in colonies where there was not much brood rearing in the fall. Young bees, plenty of stores and protected hives with the brood chamber kept warm by contracting, if necessary, give insurance against Spring Dwindling.

"Drifting." This is a term applied to the tendency of the bees to go mostly to one hive, especially in the spring shortly after they are set out. This is due to the hives being placed too close together during the time of the early flight.

MOVING BEES.

We are often asked when and how bees can be moved. This depends upon various conditions. It is possible to move them at any time of the year, but the poorest time is during midwinter when they are entirely dormant. The shaking and disturbance arouses them to such an extent that they gorge themselves with honey, as is their custom when disturbed. They are liable to consume much of this honey, and as bees normally cleanse themselves, or get rid of waste products, only during flight, and they have no opportunity for flying at that time of year, owing to unfavorable weather, the over-fed bees then often die of dysentery, which some commonly call "bee cholera."

Bees should be moved at a time of year when it is possible to let them fly as soon as they are placed upon their stand. The best time of year for moving bees is in the early spring, when some plants are in bloom that will give them food. During nice weather, at the apple blooming period, is the very best time of all the year to move bees, or to transfer them from old hives to new.

Moving Bees a Long Distance:—When bees are to be moved very far care should be taken that the bottom board is fastened to the hive with long staples provided for the purpose. The cover should be removed and a wire cloth should be tacked over the top of the hive. Then strips of wood can be tacked over this and the cover can be put over these strips of wood to insure an abundance of ventilation. The entrance to the bee hive should be closed by tacking wire cloth over it, but the open top, covered only with wire netting, is essential to provide against smothering. To merely close the entrance of the hive with wire netting may result in smothering bees within a few hours, especially in warm weather. When the writer commenced bee-keeping he paid for this practical knowledge by the loss of several of his best colonies.

We have seen bees successfully moved by tying the entire hive tightly in a sheet, after having entirely removed the bottom board, then turning it upside down and hauling in this position. This gives ventilation, which prevents smothering. To prevent accidents to drivers' and teams care should be taken that all openings of the hive are closed with wire netting, and that there are no loose bottom boards or covers to come apart or open and let out the bees in numbers.

Moving Bees a Short Distance:—Where one wishes to move the bees a short distance, as from one part of his bee yard to another, he should remember that the old bees, commonly known as "field

bees," will return to the old stand, and if they find another hive there they will enter it, and if not they will enter the nearest hive they can find. Thus when a hive is moved from place to place it loses its field bees or workers, and, of course, its yield of honey is greatly reduced, although it is a good method to pursue in checking the swarming impulse. A nucleus,—as described on another page of this bulletin,—can be established on the old stand, and the new hive can be moved to another part of the bee yard. This will generally result in the destruction of the queen cells that are started, or the destruction of all young queens but one. If, however, the hive is to be moved to a short distance, and the owner wishes to keep all the bees profitably employed and keep the colony strong, the only safe way he can do this is to move it but a few steps at a time. He can turn it with its back directly in the line he wishes to move it, and once every few days carry it backwards a few steps. The field bees will thus learn to find it each time, and will follow it to its final resting place, and but few will thus be lost. In moving bees but a short distance it can be remembered that only the old workers and the flying drones return to the old stand. The queen remains in the hive wherever it is carried, as do the young bees that have not yet become field workers, and as do especially the laying workers in the queenless hive.

WATERING.

Bees need water as well as food. All their food in the form of honey, syrup or sugar must be greatly diluted before it can be swallowed by them. As brood-rearing starts in the latter part of winter and continues during early spring, and as the honey must be diluted to about the consistency of nectar before it can be fed to the young bees, it is seen that water is especially important at this season, although at all times of the year it is necessary for the bees to have access to pure water.

One method of arranging this is to make a concrete basin about four feet across. Fill a barrel with water, through a hole near one end, and then stand it in the basin with the opening downward. The water will rise only high enough to cover the hole. Straws, chips or sticks should be scattered over the water to keep the bees from drowning. Pans of water can be placed in the bee yard, or provision should be made for bees to obtain water at some place near the watering trough for stock.

FEEDING.

It must not be thought that the bee owner can take all the feed out of the hive without putting any back. There are seasons in

the year when it is necessary for him to feed, and also some years of far greater scarcity of nectar than others when he may have absolutely no income whatever, and may be obliged to feed a great deal to his bees in order to carry them over until the next season as well as feed to induce the rearing of young bees at the right time.

Feeding is for two purposes, and consequently of two kinds:

1. *Feeding for stores.* By this we mean feeding in order that the bees may have a sufficient supply of food for winter or time of scarcity. This is perhaps the most important point of care in successful bee-keeping. Well-filled combs of honey, and more or less protected hives, with some ventilation, will carry bees well through the winter.

In feeding for stores or supplies the object of the keeper is to make sure that the bees have a sufficient amount of proper food to carry them well until they can obtain natural food for themselves. In general, each colony needs about thirty pounds of food as a minimum amount for the winter, but it is much better to have a few pounds more than needed than a half ounce less. There may be seasons when not more than one-third this amount is needed, but it will not be lost nor wasted if an abundance is given.

This food for winter can be in thick or condensed condition, like honey, rather than thin and watery, like nectar. It is best to feed it early enough in the fall that the bees can evaporate it and seal it, as sealed combs aid against dampness in the hives, and are much better for wintering purposes. There are several methods of feeding for stores, among which are the following:

(a) Simply giving the bees frames of honey. Where filled combs are at hand this is commendable, but soured honey or honey dew honey should not be given for wintering purposes, although it can well be used as food at a season when the bees have opportunity for free flight.

(b) Feeding bee candy. This can be made by boiling granulated sugar and water until it is hard enough to make candy by the regular method of making hard taffy. Before it cools stir it well, which causes it partially to granulate, but do not stir until it becomes loose sugar. Thin blocks of such candy can be either set in frames or laid over the frames and then covered with the chaff cushion in the supers. When the bees are running out of stores during midwinter, and the owner does not wish to open the brood nest for fear of losing too much heat and injuring the bees, the best method of feeding them is by means of cakes of candy thus made and laid over the frames.

(c) Thick sugar syrup is generally used for feeding bees for stores. For this purpose granulated or pure white sugar should be used. The nearer toward the dormant season the bees are fed the thicker

should be the syrup. It is generally made by using equal parts of water and sugar. A little honey can be added to give it flavor, but this is not necessary. It can all be given to the colony at one time if desired, or it can be given at different times, but it is not necessary to feed it as slowly and carefully as in stimulating feeding, discussed below.

One method of feeding syrup is to pour it into a frame of drawn comb by holding the frame and comb and on its side, and pouring the syrup from a distance above, in order that it will strike with some force and enter into the cells. When a comb is thus filled with thick syrup it can be set into the hive and another treated likewise. The more common method of feeding syrup is to use one of the various feeders that is made and sold for the purpose of feeding. While the colony is small, in order to retain its heat, the division board feeder, filled with syrup, is very good; but in general, a bottom feeder like the one known as the "Alexander," is best. Many have had good success by placing the syrup in a shallow vessel, like a pie tin, and putting straw or pieces of wood in it to keep the bees from drowning, and then setting it over the frames in the top of the hive. It is all right to use sugar syrup for feeding the bees, but all wrong to use it for producing surplus, for in doing the latter, although it may be sealed, it is not honey, and it is illegal to sell it as honey.

2. *Feeding for stimulation.* This means feeding to stimulate brood rearing. There are two very important seasons of the year when the hives should be full of young flying bees. These are at the beginning of the chief honey flow, and at the beginning of winter. If bees are neglected the honey flow itself stimulates them to rear brood, and by the time this ceases there may be many young bees ready for service, but no nectar ready for them to gather, and consequently they become only consumers and unprofitable. A good bee-keeper produces bees at the time he needs them by feeding in such a manner as to resemble a nectar flow. This means a comparatively slow and steady income of quite dilute food. For stimulative feeding, therefore, the syrup should be of about the same consistency as nectar, or one measure of sugar added to two or three of water. It can be dissolved in the water by heating, but when fed should not be more than milk warm, or, at most, 100 degrees F.

The chief art in stimulative feeding consists in giving the food dilute, in comparatively small quantities, but frequently. It should be as frequent as once per day, and not more than a pint at a time, or a half pint given twice per day would be better.

As feeding is done when the honey flow is short there is danger of starting robbing by this process at such time, and this, of course, should be avoided. The best means of avoiding it is to do the feeding

in the evening after the bees have settled. The Alexander feeder, under the bottom of the hive, is excellent for this purpose, although any kind of feeder will do by which the bees can be fed easily without disturbance. It is not best to attempt to give them syrup placed at the front of the hive when other bees are flying and will also take it. When the air is warm at night they can be fed at the entrance. The feeding should be continued until there is enough capped brood to suit the owner, or, better, until nectar flow commences.

Stimulative feeding for rearing brood for winter should continue until the young bees appear, and there is an abundance of winter stores, and should then be discontinued gradually.

BEE PASTURAGE.

It is valuable for the bee-keeper to know what the bee pasture is in his own territory. He should watch and learn for himself what plants yield nectar, and especially the quality of the honey in connection with the nectar-giving plants. The methods of treatment of bees, especially in regard to stimulative feeding, depends upon the time of blooming of the chief honey-producing plants. In a region where buckwheat is grown, or where there are fall flowers in abundance to produce stores for winter, it is possible to remove all the honey after the white clover flow and expect the bees to store enough from buckwheat or fall flowers to carry them through the winter; but where there are no late summer nor fall flowers it is necessary to feed for winter stores.

Planting for the purpose of bee pasture has been suggested, but it is now known that it does not pay to plant any crop on tillable ground for the sole purpose of feeding the bees. However, there is much that can be done toward increasing the bee pasturage in the environment of the apiary. For example, the linden or bass wood is one of the best honey producing trees, and the tulip tree comes in bloom early in the season and gives an abundance of nectar. In the city of Washington, D. C., bee-keeping is extensively practiced, and is profitable, chiefly because of the nectar produced by these very desirable shade trees. They can be planted for shade, timber and honey.

In the waste places, such as hillsides, roadsides and gullies it is possible to scatter the seeds of certain plants that are both beneficial (because soil binders and soil renewers), and also useful as honey producers. Among such are particularly to be recommended the Sweet White Clover (*Melilotus alba*) and Sweet Yellow Clover (*Melilotus officinalis*). These are biennial plants, and produce a great many small nectar-laden flowers, after most of the honey producing-plants of spring and early summer have ceased blooming.

The Sweet Yellow Clover blossoms about two weeks before the Sweet White, and by sowing the seeds of both of these the honey season is lengthened. Also by mowing them once they branch out and bloom later and continue blooming until frost. There is also an annual sweet yellow clover that is recommended.

In the regular process of good farming the leguminous plants, and especially the clovers, play a very important part, and should be more used than they are. While the honey bee does not work in the Common Red clover, on account of the long corolla, it does revel in the blossoms of the Crimson clover and the Mammoth Red clover. On poor ground and in dry soils or dry seasons the red clovers do not grow so rankly, and then their corollas are sometimes short enough for the honey bees to reach the nectar in them. An effort has been made to produce a strain of honey bees with tongues long enough to gather nectar from red clover, but it may be easier for plant breeders to produce a strain of red clover with corollas short enough for the honey bees to reach its nectar and fertilize it. Efforts in this direction are recommended to the specialists in plant breeding. (This was recommended by the writer in an address before the Pennsylvania State Bee-Keepers in 1911).

HOW TO INCREASE THE PRODUCT OF THE APIARY.

Among the different ways by which one can increase the product of the apiary are the use of modern devices and the improvement of the stock or strain of bees which he keeps. Proper attention has not generally been given to improving the stock of the bee yard, although in all other lines of live stock industry this has been emphasized again and again, until it has become the prime thought with live-stock breeders.

1. *Improve the Bee Stock.* The stock in the bee yard should be improved by the same methods that are practiced in improving live stock of all kinds. This must be by keeping careful and accurate records, rejecting those that are poor, and preserving, propagating and breeding from those that are good, and occasionally introducing some new and desirable blood. This is what the dairyman has done to improve his dairy, the poultryman for his flock, and the bee-keeper must observe and practice for his bees. The keynote of success has been in keeping records, and in taking out the "free boarders."

In every bee yard there are colonies that give very low returns, and others that give very high yields. This may be due to various causes, but it should not be due to the presence of moths or bee diseases, as it is the business of the bee-keeper to attend to these

troubles, and not let loss from them enter into his account and confuse his records. If it is due to poor queens, he will soon find this out, and destroy the old queens and introduce new ones. He should remember that he is keeping bees for honey production rather than for mere recreation. To increase the honey production his records should show the exact amount of honey taken from each colony during the entire year, and the treatment of that colony. The poor colonies should be re-queened from the descendants or offspring of the good colonies. He should not let the poor colonies produce either queens or drones, and he should not depend merely upon the introduction of queens from outside apiaries for building up the bee yard. No dairyman would think of suggesting the improving of his herd by introducing a few blooded animals from outside sources, and at the same time pay no attention to taking out the poor ones, and thus permit unchecked indiscriminate breeding.

(2) *Get Drones from Good Colonies.* Bee-keepers in the past have been giving attention chiefly to the queen only, which represents but one side of the house of bee improvement. It certainly appears reasonable that the drone from a poor colony is just as liable to impart to its offspring the undesirable traits of that colony, as is the queen from either a good or poor colony to impart to her offspring the characteristics of her own ancestry.

In bee improvement the first step should be to make sure that all the breeding bees will be only from desirable colonies with high records. Therefore, the keeper should insure against reproduction from the poor colonies. To do this he should examine the hives where the records are low, or the bees are cross, or for any other reason propagation from them is undesirable, and cut out all drone comb, and insert in its place worker comb. If he should have old-style box hives, and can not do this, he should have his bees promptly transferred to modern hives, or he can, for temporary emergency, use drone traps on the old hives.

Drone Traps:—These are little trap cages put in front of the hives to let the workers pass through, but will trap and retain the drones and queens. They can be attached to any hive, and can be purchased of almost all dealers in bee supplies.

After making sure that no drones are to be propagated from poor colonies the next effort of the bee-keeper should be to insure that they will be propagated in numbers from the best colony. He should select not only for high records in honey production, but also for temperament of bees, whiteness of capping of comb honey, reduction of the amount of propolis used in the individual colony, reduction in the number of burr combs, consideration of immunity from diseases and worms, and other points that enter into consideration for real bee improvement. Early in the spring of the year he should decide

upon which colonies he wishes to use for propagation purposes. From these he can obtain drones by setting into the brood chamber frames containing drone comb.

Here is where one of the advantages of interchangeable frames is to be found. A frame of drone comb from any hive can be suspended in the wind outside the hive a time, and the eggs or larvae will perish, when it can be set into the middle of the brood chamber of the hive desired for propagation purposes and the worker bees will clean it out. The queen will soon lay it full of drone eggs, when it can be moved toward the outer part of the brood nest, or left in the middle if desired; and the drone larvae will be cared for, and the drones will appear in about three and a half weeks. If he should not be able to find a frame containing enough drone comb, he can make one by setting together blocks of drone comb held in place by strings wrapped around the frame, or by splints of wood tacked across it in such a way as to hold the blocks or comb together. If he should not have any drone comb he can cause the bees to produce it by using a starter instead of a full sheet of foundation in the frame, and setting this into the middle of the brood nest. As the bees build down the comb in a populous colony during the spring when honey is coming in, they will be glad of the opportunity to make an abundance of drone comb. This also will be laid full of eggs in a short time. He can purchase foundation with cell bases of drone comb size and use this in choice colonies.

Now it is an easy matter to lift from its place this frame filled with eggs or brood, shake the bees off, and transfer it to another colony to receive their care. In this way the strongest of the bee colonies can be kept busy constructing two or three drone combs at a time, and filling them with eggs. These frames with eggs or larvae can be given to other colonies to rear drones, and thus satisfy their tendency in this direction, but at the same time it will make sure that the drones are propagated from the most desirable colonies.

(3.) *Obtain Queens from the Best Stock.* While it is desirable occasionally to buy new queens from the queen breeders, it is not at all necessary for the bee-keeper to depend entirely upon the purchase of queens for building up the apiary, and, indeed, it is not best for him to do so. Again the rational methods of the live stock breeder should be adopted, and these consist chiefly in making use of the records which he has been careful to keep. In buying queens, in many cases, they do not come from colonies any better than the purchaser owns.

As in drone production, every effort should be made to be sure that queens are not produced from poor colonies. To do this the owner should cut out all queen cells in poor colonies, or place queen

traps in front of the hive from which he does not wish queens to emerge. Let it be remembered that the neglected queen trap is worse than nothing, because it may trap, hold and finally kill the queen and leave the colony queenless. To avoid this it should be examined three or four times per week to see if it contains a queen or drone that should not be killed.

Just as soon as a colony is proven to be poor the queen therein should be killed and replaced with one from a good colony. When a good queen is mated with a drone which has been developed in a good colony, it is but reasonable to expect that the progeny will be of improved quality.

CAUSES OF ANGER IN BEES.

It is very important for the owner to avoid making his bees angry, and thus avoid serious trouble with them. In order to do this he should understand the causes of anger. Among these are the following:

1. *Crushing bees:* When a bee is crushed it gives out an odor which is very preceptible to its fellows, who, in recognizing that their lives are in danger, rush forth to battle. Nearly every time a hive is opened by a careless operator bees are crushed by frames that are not stapled or spaced, and especially by placing supers or covers in place. It is best for all frames to be spaced all the way around with staples or tacks, and for bees to be brushed or smoked out of the way before supers or covers are put in position. The operator should also learn to slide supers and covers on from one side, and thus push any crawling bees out of the way, rather than by placing or dropping them directly from above, and thus crushing those that may be crawling over the upper edge of the hive. The use of an enamel cloth or honey board aids in this regard.

2. *Stinging:* Sometimes an individual bee will sting the operator, while others do not appear cross. As soon as this occurs an odor from the sting becomes apparent, and others will sting at the same place. Thus after a person has been stung in the finger, for example, it is not best to work over the hive with the same hand exposed if he would avoid angering the bees. Of course, to avoid this offensive odor from the sting it is best to remove it at once, suck out the poison as promptly as possible, and smoke the spot that was stung. Smoke seems to remove or conceal the odor, and relieves the tendency of the bees to sting again in the same place.

3. *Lightly tapping the hive:* This angers the bees much more than jarring it more violently. The bee-keeper should open his hives and work with them as though he meant business. The half-hearted

method of treating bees seems to give them the advantage which may result in the operator being chased in the yard. Firmness of operation, however, should not mean carelessness in crushing the bees. Propolis or bee glue should be scraped from the parts to be moved, to relieve the sudden jarring in breaking it.

4. *The sight of hair or wool.* Women are much more liable to be stung around the head than are men. A person with a fur cap is more likely to be stung than one with a straw hat, and one wearing a straw hat with a drooping brim is most protected. Fur or wollen mittens are likely to be filled with stinging bees. This is because the sight of such articles angers the bees. They consequently should be avoided.

5. *Dark colored objects:* Two men may go into the bee yard, one wearing a black hat and the other a white one, and the man with the black hat will be attacked by a number of bees, while the one with the white hat is not molested. Dark objects thrown on the ground near the bee hive and dark articles of clothing are often attacked. When the bees are in a certain mood it is best to observe this and dress accordingly in the effort to avoid provoking attack.

6. *Certain odors:* When a person is perspiring and emitting odors he is much more likely to be attacked by bees than at other times. Also, it is well known that some persons are attacked while others are practically immune from stings by bees. The popular belief may be a fact that from those who are most attacked there are emitted odors which are offensive to the bees, although imperceptible to human beings. Some bee-keepers make a practice of washing themselves and changing their clothing before working with the bees.

7. *Breathing:* Breathing gently into the hive may cause the bees to rush forth in sudden attack. If the beginner with bees does not remember this he may have it impressed upon him by unfortunate experience when he is intently working over the occupied frames of the open hives.

Explanations: There appears to be a possible explanation of the above mentioned causes of anger in bees. Of course the reason of anger by crushing and stinging is too apparent to need further explanation, but the anger through the other causes named may be due to the inheritance or "instinct" handed down from the time when the bees lived in their native haunts in trees and rocks, and when their chief enemies were the prowling mammals,—particularly the bear,—which is especially fond of honey. The slight tapping of the hive is not unlike the scratching of the trunk of the tree by the bear in climbing it. The anger caused by persons with hairy or woollen objects can be associated with the depredations by hairy mammals, like the bear, which was the chief enemy of the bee. The

anger from the dark colored objects may likewise be associated with attacks by these dark colored enemies. Anger from the perception of odors may have its origin in the offensive odors of such mammals as the bear, giving warning to the bees of the presence of an enemy, which they would rush forward to attack. Finally, breathing into the hive may be compared with the prowling animals breathing into the holes occupied by the bees, and thus giving cause for immediate alarm and attack.

Whether the above explanation of the origin of anger in bees from various natural causes is correct may be disputed, but nothing better has yet been offered in its place, and it must, therefore, stand until a more suitable theory is brought forth. The important fact remains that bees are angered by the causes mentioned, and it is of practical value to the bee-keeper to act upon the suggestions herein given, and do all possible to avoid causing their anger.

It should further be remembered that bees are like people in the fact that when they are hungry they are easily angered, and when filled they are content. This is one explanation as to why smoking calms bees. When bees are smoked they make a frantic rush for any honey that is available and fill themselves with it. They even bite open sealed honey. In doing so they may spoil the sealed honey in the sections. In a season of great scarcity of nectar food should be given to help to put the colony in better mood before working with it.

POPULAR FALLACIES CONCERNING BEES.

In a general popular way there is much more that is not known about bees than is known. Among the fallacies are those which are corrected by the following statements:

1. The queen does not control or rule the hive in the sense of giving orders for its management.
2. The queen does not lead in swarming.
3. The queen is not mated in the hive, but when flying through the air.
4. Bees do not follow the remains of their keeper at the time of his death, and the idea is absurd to the effect that they should be notified of his death by knocking upon the hive.
5. It is not true that bees formerly owned by a person who has died will not thrive. It is remarkable how deeply rooted is this fallacy.
6. Bees do not bite open fruits, although they may suck their juices after they have been opened by other causes.
7. When a bee stings and leaves its sting it dies, and does not turn into a drone nor grow a new sting, as is sometimes believed.

8. Bees are not important factors in carrying the germs of plant diseases, such as pear blight, as these are carried by so many other means that their distribution would be practically as extensive, even if there were no bees.

9. Bees do not become entirely dormant during the winter, as is often believed, but continue to feed and change relative positions in the cluster.

10. There is no such article as "artificial honey." Honey can not be made nor sealed artificially, notwithstanding the published, popular stories in this regard.

11. Granulation of honey does not mean adulteration by sugar, as absolutely pure honey is quite liable to granulate, particularly if it becomes cold, and may remain in a granulated condition until warmed.

ENEMIES OF BEES.

The Bee Louse (*Braula coerca*): This peculiar enemy of the bee is common in Europe, but is not often found in the apiaries of America. It is a very large louse, which clings to the bee and causes it much annoyance, and is sometimes imported with bees from Europe.

It is plainly seen by examining the bees, and can be removed with a brush, or, when the worker is found with the louse upon it, both bee and parasite can be killed and thrown from the hive. Queens from Europe should be examined to see that the bee louse is not introduced into the new colony with them.

The Bee Moths or Wax Moths: There are two species of bee moths or wax moths. Both destroy the wax of combs and kill or uncap larvae, making rows of "bald-headed brood." The hives should be kept clean and inclined slightly toward the front. Split reeds, that are hollow, like the stalk of the elder, can be put in the hive with the split side downward, to give the moths or larvae an opportunity to hide in the hollow, and should be removed twice per week to kill the pests that are thus trapped.

The best remedy for the Bee moth is a strong colony of Italian bees. The Italians clean up the moth better than some other races. Old combs and neglected hives should not be permitted around the apiary, as they are breeding places for this pest.

Toads and Serpents: Toads and serpents sometimes eat bees, but they are so beneficial for the destruction of other insects that they can be tolerated without complaint. Take them away from the bee yard and keep them busy in the garden and other parts of the premises.

The Kingbird or Bee Martin: While this is too popularly supposed to be a great enemy of bees, it is really more a destroyer of those

insects, like the Robber-fly, which kill honey bees, than it is of the bees themselves. Analyses of the stomach contents show that the Kingbird feeds mostly upon drones, and is not a serious enemy of the worker.

Mice.—Among the worst enemies of bees are mice that enter the hive, especially during winter, and destroy bees and comb. The entrance to the hive should be small enough to prevent their getting in, or it should be covered with wire netting of three meshes to the inch, which will let the bees pass but keep out the mice.

BEE DISEASES.

In recognition of the fearful effects of bee diseases in the apiaries of this State and in many other states where these diseases have started, the last Legislature of Pennsylvania passed a law providing for bee inspection, which is as follows:

AN ACT

To supplement an act passed by the General Assembly, and approved March thirty-first, one thousand nine hundred and five, entitled "An act to provide for the protection of trees, shrubs, vines, and plants against destructive insects and diseases; providing for the enforcement of this act and the expenses connected therewith, and fixing penalties for its violation;" to provide for the inspection of apiaries, and for the suppression of contagious or infectious diseases among bees, and making appropriation therefor.

Section 1. Be it enacted, &c., That on and after the passage of this act, it shall be unlawful for any person or firm or corporation to have or keep in his possession or in any apiary any colony of bees infected by the disease known as American or European foul-brood, or by any other disease which is contagious or infectious in its nature, and injurious to honey-bees in their egg, larval, pupal or adult stages; and any person or firm or corporation so having in his or their keeping, or in his or their possession, any colony of bees infected, after notice of the existence of such disease has been given as hereinafter provided, shall be liable to a fine of twenty-five dollars, to be imposed and recovered as hereinafter provided.

Section 2. It shall be the duty of any person, firm or corporation, in the State of Pennsylvania, who is engaged in the rearing of queen bees for sale, to have his or their apiary inspected at least twice during each summer; and it shall be unlawful to ship from such queen-bee rearing apiaries any package or parcel containing queen bees, without having attached to it a certificate from the Secretary of Agriculture, giving the date of the last inspection, and containing the statement that the apiary in which such queen bees were reared was, at the time of such inspection, free from American or European foul-brood, or other discoverable contagious or infectious disease. Any person violating the provisions of this section shall be liable to a fine of fifty dollars, to be imposed and recovered as hereinafter provided.

Section 3. It shall be the duty of the Secretary of Agriculture, through the Economic Zoologist, or such other agent or agents as

he may select, to investigate or cause to be investigated all apiaries or other places where bees are kept or raised in Pennsylvania; and to study and investigate, or cause to be studied and investigated, all apiaries or other places where bees are kept or raised in Pennsylvania; and to study and investigate, or cause to be studied and investigated, outbreaks of bee diseases and other conditions unfavorable to development of bees within the State. It shall also be the duty of the Secretary of Agriculture to investigate all complaints of the existence of diseases of any kind in apiaries or other places where bees are kept, and to cause inspection to be made at least twice in each season, when requested by the owner, of all apiaries where queen bees are reared for sale. It shall further be the duty of said Secretary of Agriculture, wherever he finds any apiary, where queen bees are raised, free from foul-brood or other discoverable infectious or contagious diseases, to furnish the owner of such apiary with a certificate stating that fact, and such certificate shall state the date beyond which it will not be effective.

Section 4. Whenever, in the course of the inspections or investigations made or carried on, as provided in this act, by the Secretary of Agriculture or under his direction, said Secretary of Agriculture shall become aware of the existence of American or European foul-brood or other contagious diseases in any apiary or colony of bees, it shall be his duty to notify forthwith the owner or owners, or manager, of such infected or diseased apiary or colony of the character of the infection, and give directions for the treatment, both with respect to the manner of such treatment and the time within which it shall be employed or applied, which time shall not be more than eight days after the service of the notice; and in case of doubt, where the presence of disease is suspected, but cannot be definitely determined because of the character of the hives used, said Secretary of Agriculture may, at his discretion, order any owner of bees in box hives without movable frames to transfer such bees to movable frame hives, to facilitate inspection and supervision. It shall thereupon be the duty of the owner, owners or managers, upon whom such notice and order is served, to comply with said notices in all respects, within the time limited in said notices; and any person receiving such directions and notice, who neglects or refuses to comply with the same, shall be liable to a fine of fifty dollars, to be imposed and recovered as hereinafter provided; and it shall be lawful for the Secretary of Agriculture to condemn and cause the destruction of such diseased apiary or colony of bees, and all hives or other appliances used in connection with the same; and in case the Secretary of Agriculture, or his agent, is unable to agree with the owner of such apiary, colony or appliances as to the amount to be paid for the same, three disinterested appraisers shall be appointed,—one by the Secretary of Agriculture or his agent, one by the owner, and the third by the two so appointed, who shall, under oath or affirmation, appraise such property so condemned, taking into consideration its actual value and condition at the time of appraisal; and such appraised value shall be paid to the owner of such apiary, colony or appliances by the State Treasurer, upon warrant of the Auditor General, which shall be issued upon the presentation of properly executed vouchers after the same have been approved by the Secretary of Agriculture.

Section 5. It shall be unlawful for any owner or other person having diseased bees or their larvae, or infected hives or combs, or other appliances or utensils for keeping bees, to expose, sell, barter, or give away, or allow the same to be moved, until after treatment is prescribed by the Secretary of Agriculture or his agent, and the same has been applied; and it shall be unlawful to expose, sell, barter, or give away such infected bees, larvae, hives or combs, or other appliances, after treatment, until such materials are declared safe, and permission is given by the Secretary of Agriculture for such removal. Any person violating any of the provisions of this section shall be liable to a fine of fifty dollars, to be imposed and recovered as hereinafter provided.

Section 6. For the purpose of the investigations and inspections specified in this act and to enforce the provisions of the same, the Secretary of Agriculture or his agents shall have free entry upon or into any apiary or premises where bees are kept, or where infected hives or combs are liable to be stored; and any interference with, or obstruction made to prevent, such entry, shall subject the offender to liability to a fine of one hundred dollars, to be imposed and recovered as hereinafter provided.

Section 7. Any person violating any of the provisions of this act, upon conviction thereof before any justice of the peace or alderman, shall be sentenced to pay the costs of prosecution and to forfeit and pay the fine provided for in the section violated; and, in default of the payment thereof, shall be committed to and imprisoned in the county jail of the proper county for a period not exceeding one day for each dollar of the amount of the fine imposed. All fines imposed and recovered under the provisions of this act shall be paid by the justice of the peace or alderman, before whom the conviction is had, to the Secretary of Agriculture or his agent, and by him immediately conveyed into the State Treasury.

Section 8. Appropriations of the amount necessary for carrying out the provisions of this bill shall be made by the General Assembly of the State, at the time of making appropriations for the general expenses of the Department of Agriculture.

Approved—The 5th day of May, A. D. 1911,

JOHN K. TENER.

The foregoing is a true and correct copy of the Act of the General Assembly No. 140.

ROBERT McAFEE,
Secretary of the Commonwealth.

While there are minor diseases of bees, the two most important are commonly known as American Foul Brood and European Foul Brood. These diseases attack the brood or young bees, causing them to die and decay and gives off very foul odors; hence the name "foul brood." A colony infected with either of these diseases has such an offensive odor that it generally can be determined as soon as the hive is opened. The diseases are characteristic in appearance and fatal in results, if not treated. However, they can be so treated as to get rid of the disease and save the bees, without extra expense for so doing.

How bee diseases are carried: It is now definitely known that bee diseases are due to bacteria which exist in honey and are carried only in honey. Thus, when honey from an infected colony is shipped elsewhere the disease germs are conveyed with it, and if it should be fed to young bees they will take the disease known as "Foul Brood." It is possible to sterilize honey by boiling, and thus get rid of these germs. This is why all honey for queen cages or queen cage candy should be boiled. The danger of introducing foul brood with queens from other apiaries is due entirely to the possibility of its being carried in the queen cage candy with which the honey was mixed before it was put into the cage.

Treatment of bee diseases: It is fortunate that it is known definitely how to treat diseases of bees so as to get rid of them, and at the same time save the bees and equipment. The one essential point is to get rid of all the honey, without a bee carrying one drop of it to any other hive. Comb made from diseased honey does not contain the disease germs, and beeswax rendered from comb that contained diseased honey or brood likewise is free from it. Therefore, in the process of treatment there need not be very great loss, as the honey can be boiled an hour, and then use for brood-rearing, or any other purpose, and the beeswax can be saved for commercial purposes, for which it is worth about thirty cents per pound. Of course, diseased honey is in no sense unfit for food on the table. Much of it is used that is not suspected of containing these bacteria, which, of course, do not affect human beings.

The treatment consists in shaking the bees from the diseased colony on to frames, with starters or strips of foundation, in a clean hive. The honey which they carry with them in their honey sacks is used for making new comb. To make sure that none is stored in this comb all that is necessary is to shake a second time within a few days, thus transferring the bees from the second hive to a third hive, which should be prepared with frames and starters or foundation. If done with care, one shaking is generally enough, and the second treatment is not needed. Full drawn comb should not be used in the frames to receive the bees, as they are liable to deposit honey directly in the cells, and thus carry the disease germs over to where they are not wanted.

All the brood in the original hive should be destroyed by burying or burning, and all honey should be either destroyed or boiled. If it is boiled one hour the disease germs will be killed, and it can then be used. If the interior of the hive is not contaminated by being smeared with honey it is really not necessary to attempt to disinfect the hive. Some persons recommend burning out or scorching the inside with flame, but this is not essential. Some also recommend boiling hives and frames, but this is a great task which is not really

necessary, and results in distorted or twisted fixtures. If the frames have been smeared with honey they should be burned, or it is possible to scald them well or scorch them slightly and use them again.

The U. S. Department of Agriculture has published Farmer's Bulletin No. 442, on the "Treatment of Bee Diseases," by Dr. E. F. Phillips, in charge of Apiculture, Bureau of Entomology, Washington, D. C. Any person interested in this subject can obtain this very clear, concise and practical bulletin, free of charge, by writing for it to the U. S. Department of Agriculture, Washington, D. C. Therefore, it is not necessary for us to discuss at length in this Bulletin the different methods of treatment of bee diseases, or the characteristics of the different diseases of bees.

All Pennsylvania Bee-Keepers will be interested in knowing that recently local Apiary Inspectors were appointed by the Secretary of Agriculture, and the Apiary Inspection has been commenced under the direction of the Economic Zoologist, and will be continued in the same thorough and practical manner which has characterized the Orchard Inspection and Demonstration Work in this State.

The Inspectors who have been appointed hold regular certificates of appointment, and carry with them papers showing their official credentials in connection with this office. Where colonies are found infected, directions are given for their treatment, and when the diseases are eradicated an official certificate to this effect is sent from the Department of Agriculture. This is a great help to queen breeders, who according to a recent ruling of the U. S. Postal Department, must hold such certificate in order to ship their queens by mail. Further publications upon the subject of bee diseases and their treatment, and reports on the inspection work in Pennsylvania will be published from the office of the Economic Zoologist. Correspondence is solicited.

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OF THE

PENNSYLVANIA DEPARTMENT OF AGRICULTURE

VOL. II.—Nos. 4 & 5

SUBJECT: { PESTS OF FIELD, GARDEN
AND TRUCK CROPS.

JULY AND SEPTEMBER, 1912

H. A. SURFACE, D. Sci., Economic Zoologist,
Editor

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HARRISBURG:

'C. E. AUGHINBAUGH, PRINTER TO THE STATE OF PENNSYLVANIA

1912



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For September contents see page 184.

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INTRODUCTION.

Bulletins Numbers 4 and 5 of Volume II are confined to Pests of Field, Garden and Truck Crops. Future Bulletins will be published on Pests of Fruit, Forest and Shade Trees, House Plants, the Household, Poultry and Live Stock, and No. 4 of this volume should be preserved, as it contains formulæ.

All persons engaged in growing crops are acquainted with the great loss resulting from the attacks of insects and fungous diseases. Injury from these causes varies from being imperceptible to a loss of the entire crop. Careful estimates by experts place the average amount of damage by insects alone at ten per cent. of a normal crop. If to this be added the destruction wrought by plant diseases as equal to even one-half that of insects, the total of fifteen per cent. would far exceed the entire amount of taxes paid to township, county, State and Nation combined.

That this taxation, levied by pests upon the industry of the farmer, and for which no returns are made, is for the most part preventable by practical measures has been proven by our own work, by State Experiment Stations, and by intelligent and thrifty growers. Upon these experiments and researches are based the recommendations in the following pages, with the assurance that none of the measures are new or untried. The life histories and habits of nearly all insects and fungi of economic importance have been mostly worked out, and the stages in which each may be checked or destroyed are generally known. All growers should apply this knowledge to eradicate pests, and thus greatly reduce their losses. The best results in pest warfare are obtained in united efforts directed toward the same end. The migration of insects from one locality to another is generally known. Spores of fungi are carried long distances by the winds and other agencies. Insects and diseases are disseminated by transported seed and plants. Co-operation, therefore, in all efforts directed against pests is strongly advised among all growers.

The Hessian fly is an example showing how isolated efforts to control insect pests may result in failure. This insect which was so destructive in this State during the summer of 1911 that a number of farmers have temporarily abandoned wheat growing, produces two generations each year,—one in the fall and another in the spring. Late seeding of wheat effectively protects a field from the fall brood, but does not prevent spring infestation of such fields by eggs laid by Hessian flies, wintered over in neighboring fields sown early and infested the preceding fall.

PRINCIPLES OF PEST WARFARE.

Plant pests are of two general groups: (a) Insect Pests, and (b) Plant Diseases.

Insects Pests feed on plants in at least one stage of their existence, and at such time prey upon roots, stem, bark, foliage or fruits at various seasons throughout the year. It is necessary that growers know the habits and life histories of insects of economic importance, so that the proper kind of treatment can be applied at the time when they are least able to resist their action or can be reached, and before much harm has been done to the crops. As a rule the eggs of insects are difficult to destroy, since in this stage they are more resistant than at any other time. In the larval stage, when feeding greedily in order to make abundant growth, insects are usually least resistant to agencies applied to destroy them or are more easily reached, and one should take advantage of their condition at this time in applying treatment for their destruction. In the pupa or resting stage they do not feed, and sometimes are protected by a more or less impervious covering or are buried in the soil or otherwise protected, so that the only effective means we may apply to overcome them is breaking the covering mechanically, or exposing them to the attacks of insectivorous birds or other animals or destroying their retreats, as by plowing and cultivating infested ground, or by burning them. Many species of insects do not feed in the adult stage at all. In addition some are protected by a chitinous or horny substances, which resists all ordinary efforts aimed at their control.

All insects do not feed in the same way. With regard to the manner in which they take their food they can be classified into (1) Chewing Insects, and (2) Sucking Insects.

Chewing Insects are supplied with maxillæ or jaws with which the substance of plants on which they feed is comminuted or chewed before being swallowed. This method of feeding is taken advantage of in destroying them. Any internal poisons, such as the common compounds of arsenic, applied to their food materials will, also, be ingested or swallowed, and the insects destroyed by wholesale. It is important that any poison put on plants for this purpose should not be of such a nature and strength as to injure the plants. It should, also, be cheap, so that its use will be economical to the grower. Paris green, arsenate of lead (both in the paste and powdered form), arsenite of lime, arsenite of zinc, white arsenic, green arsenoid and London purple are the forms of arsenic mostly used in poisoning insects. Other internal poisons are hellebore or "slug

shot," which is recommended to be used on parts of plants soon to be consumed as human food, since while it is poisonous to the insects, it is not fatal to mankind. Pyrethrum or Buhach can, also, be used for the same purpose.

Sucking Insects cannot be killed with internal poisons applied upon plants as for chewing insects. Letters are still occasionally received at this office containing the statment that "trees were sprayed several times with Paris green and still the San José Scale insects infesting them have not been killed." Suctorial insects could not be injured by these poisons, even if they were covered with them. The reason of this is that they do not commence to feed until after they insert their beaks beneath the poison, and then live by sucking the sap through the beak or proboscis which has been inserted into the tissues of the plants. Sucking insects must, therefore, be destroyed by the use of contact poisons. These are substances which as a rule, are not harmful if swallowed in small quantity by human beings. They kill by coming into contact with the bodies of the insects, and mechanically close up their spiracles or breathing pores, thus suffocating them; or else they enter the bodies through the spiracles and are taken up into the circulation, and kill by their effect upon the blood. We have a large list of contact sprays to select from. Care should be taken to use only such as will not injure the host plants or infested crops, or use them properly diluted. The most common contact insecticides are soft soap, laundry soap, fish-oil soap, tobacco extract or decoction, kerosene in the form of soap emulsion, carbolic emulsion, Hellebore, lime-sulphur solution, creolin, carbon bisulphide and hydrocyanic acid gas. Pyrethrum, fine sulfur, pulverized tobacco, wood ashes and air-slaked lime act mechanically in killing some insects when dusted upon them.

(b) *Plant Diseases.* Plants are subject to attacks from parasitic fungi and bacteria which feed upon them by breaking down their tissues and absorbing their substances, thus stunting growth and finally killing the plants. A fungus may be simply defined as a minute plant, unlike the higher forms of vegetation in structure and methods of living. Fungi are unable to elaborate food from inorganic substances, and, therefore, must live on organized matter; hence their growth on plants. Bacteria are still more simple and primary forms of life than fungi, to which they are closely related. They are usually composed of single cells, so small as to be scarcely visible under high power microscopes.

The presence of insects upon plants can usually be readily determined by examination, while plant diseases, as a rule, must be recognized by the effects of their injury. The principal symptoms of diseases of plants are the following: 1. Discoloration or change

of color from the normal green to yellow or white colored spots or areas, as white or gray on stems, such as mildew or rust. Many leaf spots, of yellow, red, orange, brown or variegated colors; red or orange rusts, black rusts, and the like. 2. Shot-hole perforations of leaves. 3. Wilting, such as damping-off or wilt. 4. Necrosis, such as death of parts of plants, leaves, stems, twigs, or flowers. 5. Reduction of size, such as dwarfing or failure to develop. 6. Increase in size, such as abnormal development or enlargement. 7. Replacement of organs by new structures. 8. Mummification or drying. 9. Destruction of organs. 10. Excrescences and malformations, such as pustules, tumors, cankers, knots, hairy root, etc. 11. Exudations, such as slime or gum. 12. Rotting, such as dry and soft rots, fruit rots, stem rots and root rots of the very fleshy roots. In general, any marked variation in color or shape from the normal type is an indication of disease, which in many cases may be controlled and the crop saved if taken in hand promptly.

B. PRACTICAL MEASURES HELPFUL IN PEST CONTROL:

I. *Farm Practice.*

(1). Rotation of Crops, as for Wire-worms, Corn-root-Worms, Cabbage-Root-Worms, Hessian Fly, etc.

(2). Selection of Good Stock or Seed.

This is necessary with both plants and animals in order to secure vigor, which means greater resistance to diseases and pests, and to obtain the best results.

(3). Starting Plants Early and Setting Strong Plants.

By getting ahead of the insects at the start one can often keep ahead of them. This is especially true of such pests as the Striped Cucumber-Beetles, Flea-Beetles and others.

(4). Proper Dates of Farm Operations.

(a) Of Plowing,—as in plowing very late in fall and very early in spring for Cut-worms, Wire-worms and other insects in the soil, and also midsummer plowing to destroy the Hessian Fly in wheat stubble.

(b) Of Planting,—as in planting wheat late to avoid the Hessian Fly, planting cabbage early to avoid Cabbage-Root-Worms, and planting it at such time as will come between the broods of this pest.

(c) Of Cultivating,—as in cultivating late in fall and early in spring to avoid Cut-worms and Wire-worms.

(d) Of Harvesting,—as in gathering cabbage before it is attacked by Black Rot, picking berries before they are injured by fruit-eating insects and birds, and mowing clover hay before the Clover-head Midge is sufficiently mature to pass to the ground and live.

(5). Early destruction of all Unused Parts of Plants.

This is important whether insects or plant diseases be present upon the plants or not. As soon as peas are picked the vines should be burned to destroy the Pea Lice and mildew; when cabbage is cut the stalks should be burned; when potatoes are lifted from the ground the vines should be burned; as soon as strawberries are picked the leaves should be mowed as closely to the ground as possible, dried quickly in the hot sun, raked together and burned. This will destroy leaf blight and other pests. When blackberries and raspberries are gathered, the canes should be cut at once and burned. When wheat is harvested in which Hessian Fly was present the best means of preventing its recurrence the coming fall is to plow down or burn over the stubble at once. This is an important principle to apply to nearly all crops.

(6). Clean Farming.

(a) Clearing away Rubbish,—as in burning brush, leaves and grass, etc., to destroy the hibernating places of insects and the abodes of mice.

(b). Clearing away Weeds,—as in destroying mustard and preventing the occurrence of lice and root worms injurious to cabbage and other cultivated plants of the mustard family, and in frequently mowing all weeds to destroy the stalk-borer. Many kinds of weeds are liable to sustain insects that may become injurious to various cultivated plants, and even plant diseases are at times transferred from weeds to cultivated plants. Prevent this by this important method of clean farming.

(c) Clearing away Volunteer Plants, etc.,—as in destroying the volunteer or self-planted wheat stalks of late summer to prevent the Hessian Fly from developing on them and becoming a menace to cultivated crops planted later. The destruction of wild or volunteer fruit trees by the tens of thousands in this State would prove of immense value to the careful orchardists who spray continuously for the Codling Moth and other orchard pests, such as the Tent-caterpillar and scale insects, and as regularly have their orchards reinfested by the pests that are continually propagated upon the wild or seedling fruit trees in their regions.

(7). Proper and Frequent Cultivation.

Not only are plants greatly strengthened by this important means of farm practice, but insect pests and plant diseases are greatly discouraged thereby.

(8.) Draining Wet Land,—as for Cut-worms and Wire-worms, and especially Mole Crickets in damp soil.

(9). Irrigating Dry Land, or Occasionally Flooding.

Wherever it is possible to flood land for a few weeks during the fall or winter, the pests in that soil will be killed. Recent Bulletins have shown that the best method of treating some pests, such as various kinds of cranberry insects, is to flood the cranberry bogs for even a short time (24 hours) occasionally while the pests are on the growing plants.

(10). Use of Quick-Acting Fertilizer for Infested Plants.

It is recommended to strengthen certain plants, such as wheat, by sowing over them when infested some quick-acting fertilizer, such as nitrate of soda, one hundred to two hundred pounds per acre. This acts as a stimulant during the time when insects are most likely to have a devitalizing effect.

(11). Killing Pests While Few in Number.

Occasional outbreaks of insects in great numbers are often due to neglect while they are but few. This is especially true of the Stinking Squash Bug, which may not be perceptibly injurious while few in numbers, and consequently might be neglected, with the result that during the next season they may become very abundant, and it would then be almost impossible to treat them effectively.

(12). Planting Trap Crops to Catch and Destroy Pests.

A trap crop may be an early planting of seeds of plants of the same kind to be protected, as in planting early squash to become well started and receive the eggs of the Squash-Borers and protect the later and more desired crop; or as in planting a strip of early wheat at the side of the field, which is to be sown later, and thus trapping the Hessian Fly, which will lay its eggs in the early strip. By destroying the trap crops when the pests have become well started in them, the insects are exterminated or suppressed. Another kind of trap crop consists of some kind of plant that may be used to take insects from cultivated plants, as in planting mustard seed to produce plants to catch the Cabbage Root-Worms and Cabbage Plant-Lice, and destroying these plants when infested, or planting a few beans among cucumbers or melon plants to attract Flea-Beetles from the vining plants.

(13). Mechanical Devices.

(a) Protecting Plants by Nets, Boxes, etc.,—as in covering vining plants with nets to keep out Cucumber-Beetles, Squash-Bugs, and other pests.

(b) Paper Pads or Disks around Plants, as in splitting disks of heavy paper, and putting them flat on the ground around cabbage plants to prevent flies from laying the eggs that hatch into Cabbage Root-Worms.

(14). Impassable Barriers.

(a) Ditches, Furrows and Holes, such as are made around fields that would be attacked by migrating hosts of insets, such as Army-worms, the young of wingless Grasshoppers and Chinch-Bugs.

(b) Line of Tar, as in making an impassable band to serve the same purpose for similar pests.

(c) Tin, Boards, etc., placed around fields or plants to be a protection to prevent certain insects, such as wingless Grasshoppers, from passing them.

II. *Chemical Preventives or Repellants.*

(15). Ashes, Soot, Dust, etc.

These substances are used around beds of plants in gardens to keep out such pests as snails and slugs, and may also be dusted over plants to prevent insects from attacking them.

(16). Fish Oil.

The chief virtue of Fish Oil is as a repellant, rather than as a means of killing insects.

(17). Kerosene.

Kerosene,—Sand. By adding a quart of kerosene to about one peck of sand and stirring it well, a mixture is made which will repel insects, and keep them from laying their eggs around the roots of plants, as in placing a handful of this mixture near the roots of cabbage plants or around onions for preventing the root-worms of these plants.

(18). Tar, as in using a teaspoonful of tar in a quart of warm water to pour over one-half bushel of corn to make it bitter and prevent crows from pulling it, and ground-inhabiting insects from eating it while in the ground. (Note that this will only protect the grain and not the young shoots that come from it).

(19). Lime, as in dusting this substance over the leaves of plants, such as cucumbers and melons, to prevent insects from attacking them. Its value as a repellant will be increased by the addition of a little turpentine.

(20). Nitrate of Soda.

This is recommended to mix in the soil around the roots of plants to strengthen them, at the rate of one hundred to three hundred pounds per acre. It acts not only as a quick fertilizer for plants, but also as a repellant to keep out certain insects.

(21). Turpentine.

When added to lime or sand or some other substance that will absorb it and placed around plants on the ground it has some effect in repelling certain kinds of insects, but turpentine should never be used directly on trees or plants as it injures them.

III. *Vital Means.*

(22). Strengthening crops by Fertilizing, Cultivation, Pruning, Thinning, Watering, Draining, etc.

Every means by which plants can be strengthened is a vital means of enabling the plant to withstand the attacks of enemies, whether they be insects, plant diseases, or other pests.

(23). Destroying Allies or Injurious Pests, as in using various means to destroy ants in corn fields that carry the root lice on corn plants.

(24). Preserving Beneficial Insects, as in watching for Lady Beetles, or "ladybirds," or parasites on our various insects, and permitting them to remain undisturbed.

(25). Preserving Insectivorous Reptiles, Birds and Mammals, such as Striped Snakes or Garter Snakes, Black Snakes, Green Grass Snakes, nearly all Birds, and also Skunks, Moles, Toads, etc.

C. CURATIVE MEASURES FOR PESTS.

Insects are destroyed when they are found feeding or about to feed. Plant diseases, while they may sometimes be arrested when present, are best controlled by preventive treatment before they appear in their growing forms. Spores of diseases may be controlled by applying treatment upon them wherever found. Poisons used to kill insects are called "insecticides." Materials used to control plant diseases are known as "fungicides" or "germicides." Insecticides are divided into (a) internal poisons and (b) contact insecticides, these terms having reference to the manner in which they act upon the insects. There are many materials which can be used effectively as insecticides, and also many fungicides, but during recent years there has been a tendency among Entomologists and Plant Pathologists toward reduction of materials and greater simplicity in methods of treatment recommended, to avoid unnecessary confusion. We give herewith a list of the principal materials used in treating pests of field, garden and truck crops.

IV. *Internal Insecticides for Chewing Insects.*

(26). *Paris Green.*

a. As a liquid for spraying:

Paris green, 8 ounces.

Fresh lime, 1 pound.

Water, 50 gallons.

Slake the lime in a small quantity of water and stir the Paris green into enough water to form a paste, and add more water and strain into the spray tank. The liquid should be agitated frequently during application. This is not as commendable as arsenate of lead.

b. Dry Mixture, for Dusting.

To 50 pounds of air-slaked lime, leached wood ashes, or dry road dust, add one pound of Paris green. Mix thoroughly by sifting, and apply when the leaves are damp with dew or rain.

(27). *Arsenate of Lead.*

a. Ordinary Strength: arsenate of lead paste.

2 pounds; or powder, 1 pound.

Water, 50 gallons.

b. Extra Strength: arsenate of lead, 4 pounds.

Water, 50 gallons.

c. Arsenate of lead powder.

Mix the quantity of arsenate of lead with a small amount of water by rubbing with a paddle or spoon; strain into the spray barrel, and add the water. It should be agitated occasionally during application. Do not attempt to use arsenate of lead which has become dry and granulated, as it is impossible to break up the granules fine enough to make it effective. To prevent the paste from drying out keep the arsenate of lead paste covered with water. The 2-50 formula is the most used of all arsenicals.

(28) *Green Arsenoid and Green Arsenite.*

Either of these materials can be used in the same manner as Paris green, and in some respects they are to be preferred, as they cost less and contain no free acid, hence do not burn the foliage.

(29). *White Arsenic Compound.*

White arsenic, 1 part.

Flour, 20 parts.

Powdered sugar, 20 parts.

This is a valuable poison when compounded as above, although owing to the great amount of free acid which white arsenic contains it can not be used upon the foliage of plants, excepting as a dilute powder.

(30). *Poison-Baits.*

(a). Fresh Baits.

These are prepared by dipping slices of potatoes, apples, or bunches of clover, into solutions or arsenical poisons, or dusting them while wet with arsenical poisons and spreading them around the plants to be protected.

(b). Poisoned Mash.

White arsenic or Paris green, 1 pound.

Brown sugar or molasses, 1 to 2 pounds.

Bran (part Middlings), 40 pounds.

Mix thoroughly and then add water sufficient to make a damp but not sloppy mash. Strong molasses will take the place of brown sugar.

During the evening put a small pinch at the base of each plant to be protected, or in rows near plants likely to be attacked by pests. Put under boards to protect from fowls. Especially useful for cut-worms.

(c). Criddle Mixture.

Paris green, 1 part.

Salt, 2 parts.

Fresh horse manure, 100 parts.

Mix the Paris green with water; incorporate this with the manure and then add enough water to make a soft mash. Salt is not necessary in using fresh manure. Use the same as Poison Mash. Especially good for Grasshoppers.

(31). *Hellebore*.

a. Mix with five times its bulk of flour and keep in a closed vessel. Dust the dry powder on plants infested when they are damp with dew or after the leaves have been sprinkled with water.

b. Decoction.

Hellebore, 1 ounce.

Water, 2 gallons.

Apply as a spray.

V. CONTACT INSECTICIDES FOR SUCKING INSECTS.**(32). *Kerosene Emulsion (Stock Emulsion)*.**

Hard soap, $\frac{1}{2}$ pound.

Hot water, 1 gallon.

Kerosene, 2 gallons.

Dissolve the soap by chipping it fine into the hot water and stirring; remove from stove, and add the kerosene while the water is still boiling hot. Churn thoroughly or pump through a spray pump until the creamery emulsion is formed. (When a small quantity of emulsion is wanted sour milk can be substituted for soap and water. Simply beat it together with the kerosene). To dilute for use add:

a. One part of *strong* stock emulsion to 7 of water, to make an 8 per cent. dilute emulsion.

b. One part of *strong* stock emulsion to $5\frac{1}{2}$ of water, to make a 10 per cent. dilute emulsion.

c. One part of *strong* stock emulsion to 15 of water, to make a 4 per cent. dilute emulsion.

(33). *Soap Solution.*

a. Common hard soap, 1 pound.

Water, 4 gallons. For plants in foliage.

b. Fish-oil soap, 1 pound.

Water, 6 gallons. For plants in foliage.

Dissolve the soap in one gallon of hot water. Add the remainder of the water, either hot or cold.

(34). *Lime-sulfur Solution (Concentrated).*

Boil together for one hour (in any kind of vessel excepting copper):

Fresh Lime, 1 pound.

Sulfur (Flowers, flour or powdered commercial).

2 pounds.

Water, 1 gallon.

Strain and store away in closed vessels until wanted. As a fungicide on growing plants dilute one part of the concentrated solution with from 50 to 150 parts of water. (This is used as a dormant tree spray by diluting with 8 times its bulk of water).

(35). *Self-Boiled Lime Sulfur Mixture.*

Lime, 8 pounds.

Sulfur (flowers, flour or powdered commercial).

8 pounds.

Water, 50 gallons.

Place the lime in a barrel and pour on enough water to cover it. When it begins to slake add the sulfur, having first broken up the lumps by sifting or by making it into a thick paste with water. The mixture should be constantly stirred and more water added as needed, to form a thick paste at first and gradually a thin paste. It should be allowed to boil or bubble but a few minutes (about ten), or until the lime is slaked, when water should be added to cool the mixture and prevent further boiling. Dilute to 50 gallons; strain and apply as a spray. Add any poison for chewing insects if needed.

(36). *Carbolic Emulsion.*

Hard soap, 1 pound.

Boiling water, 1 gallon.

Crude Carbolic acid, 1 pint.

Shave the soap and dissolve it in the hot water; pour in the carbolic acid and churn or beat into a creamy emulsion. Use one part of the emulsion to 15 of water. (See Plates Nos. 20 and 21.)

(37). *Carbon Bisulphide.*

a. One ounce to every 100 cubic feet of bulk or 100 bushels to be treated.

b. One ounce to every 50 cubic feet of capacity.

This is a heavy liquid with an offensive odor. It is very volatile and evaporates readily when poured into an open vessel, setting free a poisonous gas which must not be inhaled. This gas is also explosive and fire must be kept away from it.

(38). *Hydrocyanic Acid Gas.*

The formula for every 100 cubic feet of space is:

Potassium cyanide (98 per cent. pure), 1 ounce (by weight); Sulphuric acid (1.83 specific gravity), 2 ounces (by measure); Water, 4 ounces (by measure).

Place the proper amount of water, according to the size of the room, in an earthen vessel. Add the sulphuric acid to the water, close the room tightly and, when ready, drop the cyanide into the vessel. This is one of *the most deadly* and also most efficient gases known, and great care should be taken not to inhale even a single breath of it. Recommended for use only by careful or experienced persons. (See our previous articles on Fumigation in the Monthly Bulletins of the Division of Zoology).

(39). *Lime.*

Dust with freshly air-slaked lime.

(40). *Pyrethrum.*

a. Pyrethrum powder, 100 grains.

Water, 2 gallons.

Used as a spray.

b. The pure powder burned in a room, using a bee-smoker for the purpose.

c. Pyrethrum powder, 1 part.

Flour, 4 parts.

(41). *Tobacco.*

a. Tobacco decoction. Made by steeping 1 pound of tobacco leaves or waste, or of the midribs or "stems," in 2 gallons of water for a few days; or by soaking a quantity of tobacco one-half hour in sufficient water to cover it, and slowly raising the water to near the boiling point and allowing it to cool. Dilute with water, making 2 gallons for every pound of tobacco used. There are several reliable prepared tobacco extracts on the market, sold under various trade names, and these are satisfactory when not too greatly diluted. Follow their directions.

b. Tobacco dust or finely ground stems. Apply as dust.

VI. FUNGICIDES.

The formulæ under this head are not insecticides, and should be used only to prevent plant diseases. They can be made to serve both as insecticides and fungicides by the addition of stomach poisons. (See Combined Insecticides and Fungicides.)

(42). *Bordeaux Mixture.*

a. Standard Bordeaux Mixture.

Copper sulphate, 3 pounds.

Quick lime, 4 pounds.

Water, 50 gallons.

b. Weak Bordeaux Mixture.

Copper sulphate, $1\frac{1}{2}$ pounds.

Lime, 3 pounds.

Water, 50 gallons.

c. Strong Bordeaux Mixture.

Copper sulphate, 5 pounds.

Lime, 5 pounds.

Water, 50 gallons.

Dissolve the copper sulphate (bluestone) by suspending it over night in a burlap bag just beneath the surface of the water (or put it in boiling water, using at least one quart to the pound), and dilute to 25 gallons. Slake the lime in sufficient water to prevent burning. Strain into the spray tank with about 25 gallons of water, and add the copper sulphate solution, stirring the mixture vigorously while mixing.

Stock solutions of copper sulphate and of lime can be made by using a pound of either to a gallon of water. To make up the mixture in any strength desired, use one gallon of the respective stock solutions for one pound of either copper sulphate or lime needed. These solutions should not be mixed when concentrated. Dilute one or both before mixing.

Slaked lime in the form of paste can be used and in this shape can be kept indefinitely under water. Three times as much of this lime paste (by weight) as fresh stone lime should be used. Air-slaked lime should not be used in making Bordeaux Mixture.

If the lime be of good quality there will be no danger of burning the foliage by using the above formulæ. If, however, there is any doubt about the quality of the lime used, a test for free acid (which burns the leaves) should be made by one of the following methods:

1. Hold a clean bright knife blade in the Bordeaux Mixture for about a minute. If it becomes copper coated more lime should be added.

2. Pour a small quantity of the Bordeaux Mixture into a saucer and breathe gently upon it. If it be properly made a thin white pellicle or film of calcium carbonate will form on the surface. If this does not occur more lime should be added.

3. Dissolve one ounce of ferrocyanide of potassium in 5 or 6 ounces of water. Pour a few drops of this into the Bordeaux to be tested, preferably in a white or glass vessel. If it turns brownish-red more lime should be added.

(43). *Copper Carbonate Solution.*

Copper carbonate, 5 ounces.

Ammonia (26° Baume), 3 pints.

Water, 45 gallons.

Dissolve the copper carbonate in the ammonia. This may be kept as a stock solution. When ready for use dilute with the required amount of water. This is a clear liquid with a bluish tint, and is used instead of Bordeaux mixture when there is objection to staining the fruit, flowers or foliage, as upon celery, roses, and ripening fruits.

(44). *Potassium sulphide (Liver of sulfur).*

Potassium sulphide, 1 ounce.

Water, 2 gallons.

This mixture loses strength on standing and should be made just before it is required for use. (Sodium sulphite will take the place of the potassium sulphide).

(45). *Formalin.*

- a. Strong formula, Formalin, $\frac{1}{2}$ pint.

Water, 15 gallons.

- b. Weak formula, Formalin, 1 pint.

Water, 50 gallons.

This has been found to be the best remedy for destroying fungous spores on seed grain and potatoes before planting. (See "Oats" and "Potatoes").

(46). *Sulfur and Lime.*

Sulfur (flowers, flour, or powdered commercial), 2 pounds.

Lime (air-slaked), 1 pound.

Mix ingredients thoroughly. For Mildew, Mites, and Club-Root of cabbage.

VII. ADHERENTS. (To make spray material stick).

(47). *Resin-Lye Mixture.*

Pulverized resin, 5 pounds.

Concentrated lye, 1 pound.

Fish-oil or other animal oil, 1 pint.

Water, 5 gallons.

Place the oil, resin, and one gallon of water in an iron kettle, and heat until the resin softens. Then add the lye and stir thoroughly. Now add four gallons of hot water, and boil until a little of the mixture, when dropped into cold water, will mix with it and give a clear, amber-colored liquid. Add water to make up for evaporation and make the entire mixture 5 gallons. Keep this as a stock solution, and add two or three gallons to each barrel of liquid spray, whether it be Bordeaux mixture, or Paris green and water, or other material, to make it stick. Use on cabbage, cauliflower, asparagus, etc.

(48). *Resin-Fish-Oil Soap, or Whale-Oil Soap.*

Use 3 or 4 pounds to 50 gallons of spray fluid. This is a commercial article and can be bought in the agricultural supply stores. It makes all spray materials stick better.

(49). *Glue.* A few pounds of glue in a barrel of spray liquid will make it stick. ..

(50). *Soap.* Three or four pounds of soap of any kind in a barrel makes a good "sticker."

VIII. COMBINED INSECTICIDES AND FUNGICIDES.

51. (*Bordeaux Mixture and Paris Green.*

Paris green, 5 to 8 ounces.

Bordeaux mixture (No. 42), 50 gallons.

Test for acidity and correct it by adding lime, if needed before spraying.

(52). Bordeaux Mixture and Arsenate of Lead.

Arsenate of lead, 2 pounds.

Bordeaux mixture (No. 44), 50 gallons.

The adhesive qualities of the arsenate of lead will tend to keep the Bordeaux mixture on the tree much longer than it would otherwise remain if sprayed alone. This is next to the best and cheapest combined fungicide and insecticide for chewing insects.

(53). Dilute Lime-Sulphur and Arsenate of Lead.

Dilute Lime-sulphur solution (No. 34), 50 gallons.

Arsenate of lead paste, 2 pounds.

(Or arsenate of lead powder, 1 pound).

(54.) Self-Boiled Lime-Sulphur Mixture and Arsenate of Lead.

Arsenate of lead, 2 pounds.

Self-boiled Lime-sulphur mixture (No. 6), 50 gallons.

Arsenate of lead or Paris green can also be added to the other kinds of lime-sulphur solutions, the same as to water or Bordeaux mixture, when desired.

(55). Resin-Bordeaux Mixture.

Resin-lye mixture, 2 gallons (47).

Bordeaux mixture, 48 gallons.

This combination is valuable as a spray upon cabbage, asparagus, onions, etc. Paris green or arsenate of lead can also be added when desired for use as an insecticide when needed.

PLANTS AND THEIR PESTS.

ASPARAGUS.

I. *Chewing Insects.*

Asparagus Beetles. Asparagus shoots and foliage are attacked by two species of beetles similar in appearance, which, in both their larval and adult stages, feed upon this plant. They are red, yellow and black insects, from one-fourth to three-eighth of an inch in length. In the early spring the beetles, which pass the winter in rubbish in the mature stage, appear upon the young shoots and eat roundish holes into them, thus making them unfit for market. They deposit

their small, long black, eggs on end in rows upon the shoots. From these hatch in a few days, dark, slug-like larvæ, which feed on the shoots or foliage and become full grown in about two weeks and then descend into the ground to pupate. In ten days or two weeks longer they emerge as mature beetles. There are at least three generations each season in this State.

Control: Where these insects are known to do damage young shoots should be cut as soon as they are in marketable condition. Destroy all voluntary growths of asparagus. Use a few plants in the asparagus patch as a trap crop upon which the insects are allowed to deposit their eggs, and destroy these together with the eggs and larvæ upon them before the time of pupating. Rake together and burn all rubbish near the asparagus bed in the late fall.

These insects can be readily destroyed while feeding upon the foliage of the plants after the time of harvesting the shoots by spraying with

Arsenate of lead, (27* a), (27 b).

Resin soap, 3 pounds, (48).

Water, 50 gallons.

Resin soap is added to make the poison stick. As a substitute for the resin soap two or three gallons of resin-lye mixture (47) can be used.

II. *Diseases of Asparagus.*

Rust. Asparagus Rust has been known to exist in certain market gardening sections of this State for some years and, where found, is a serious menace to the asparagus growing industry. It causes premature death of the tops; which grow after the cutting season, and thus reduces the vitality of the plant. The rust fungus develops in three distinct stages, first appearing early in the season as elliptical, light green, cushion-like areas upon the stems of the plants. The red stage follows shortly after when these areas become covered with duty red powder during the summer. Still later in the season the rusty areas turn dark in color, because of the formation of numerous black pustules upon them.

Control: Plant resistant varieties, such as Palmetto. Since it has been found that the rust fungus thrives best in a moisture-laden atmosphere, provision should be made for the best circulation of air possible; thus plants should be set on soil located in such a manner as to insure good air drainage, the rows planted a sufficient distance apart, and the field to be free from obstructions around the border.

Asparagus beds known to have been infected with rust should be sprayed soon after the tops begin to form, and every week or ten

days thereafter, with either Bordeaux mixture (No. 42 a), or lime-sulphur solution (34) or (35) in which two gallons of resin-lye mixture (47) have been dissolved. Begin before the first signs of rust appear. Dusting the stalks with fine sulphur frequently when they are wet with dew, beginning soon after the crop has been harvested, is also recommended as a preventive. Keep the patch well cultivated during the summer. Irrigation of the patch, where this is possible is also recommended. Burn the stalks as soon as frost kills them.

BEANS.

I. *Chewing Insects.*

Cut-Worms. (See under CORN).

Bean-Weevil. The insect, which is responsible for "buggy beans" so well known in most sections where beans are grown, is a beetle of a brownish gray color, about one eighth of an inch in length. Its wing covers are noticeably shorter than the abdomen, and it carries its head bent at right angles to the body, with a long snout projecting beneath.

There are several generations each year. The eggs of the first generation are usually laid inside the growing pods, through openings gnawed into them by the female, the larvæ being hatched inside the beans, often several in a single seed. They feed upon the interior of the bean, sometimes leaving but a thin shell, within which they pupate, and upon maturity emerge through an opening in the side of the bean. Later in the season eggs are laid in dry beans and other seeds which in turn become infested. If the germ of the seed has not been destroyed by the weevil it may grow when planted, but the use of infested or inferior seeds of all kinds is not recommended, for the reason that such seeds serve not only to expose the crop to further infestation, but even if they germinate are sure to produce plants of reduced vitality.

Control: Fumigate all infested beans in the fall as soon as they are stored, with carbon bisulphide, (No. 37 a). It should thus be poured into a shallow vessel, placed in a slight depression on the top of the bin or enclosure containing the infested beans, and the whole tightly closed or covered over with a wet blanket and left covered for several hours, after which time the covering can be removed and the enclosure freely ventilated. Fumigation by carbon bisulphide is best when the weather is not too cold, since the gas is less efficient in very cold weather. The fumes are poisonous to human beings when inhaled, and are also explosive and must be kept away from fire.

In selecting seed from infested beans they should be poured into a vessel containing water. The sound seeds will sink to the bottom and the infested ones will float. The latter can then be separated and destroyed.

Flea-Beetles. The flea-beetles are small leaf-eating insects somewhat resembling fleas, their hind legs being made for jumping. These insects feed upon a variety of field, garden and truck crops, among which are beans, peas, beets, tobacco, turnips, cabbage and allied plants. Some plants are attacked by several species of flea-beetles. The most troublesome on beans is probably the pale striped flea-beetle. Flea-beetles appear in myriads during hot, dry weather. The beetles are only about one-eighth of an inch in length, dark-green colored, or with light brown stripes on the wing covers. The larvæ are white, slender, thread-like creatures which do not feed upon the leaves, but feed under ground on the roots of plants. The injury done by these tiny beetles consists of eating holes into the surface of the leaves, which injury often causes them to shrivel, and while young sometimes kills the plant entirely. This injury also permits entrance of diseases.

Control: Since the beetles pass the winter in the adult stage, all rubbish and remains of infested plants should be burned in the fall of the year. Bordeaux mixture acts as a repellant for all flea-beetles, and the treatment of infested plants with this spray is advised. Bordeaux mixture with four or five pounds of arsenate of lead paste to fifty gallons of mixture (52) is better, since the arsenate of lead will tend to kill the insects feeding upon the leaf tissue. Especially is this spray advised where the development of fungous diseases is anticipated.

II. Sucking Insects.

Aphids or Plant Lice. Aphids are small suctorial insects, less than one-eighth inch in length. They vary in color from light green and gray to red and black. Their bodies are pear shaped, and on the back of the abdomen in many species there are a pair of "honey-tubes." Upon the "honey-dew" dropped from these insects, ants are often found feeding. The presence of ants upon plants is generally an indication of aphid infestation. They are often so thickly crowded upon plants that the mass of insects superficially resembles mold or mildew and for this reason they become known by such names as "Blight" and "Mildew," but they are true insects and not fungous diseases.

There are numerous species infesting field, garden and truck crops, as well as certain weeds. Different species are known by the class of plants upon which they are usually found, as the bean aphid, the cabbage aphid, the European grain aphid, the melon aphid, the cucum-

ber aphid, etc. Some have forms feeding under ground on the roots, and others on the leaves and stems. They live by sucking the juices from the tissues of the plant, usually fastening themselves on the under side of the leaves. This results in checking the growth of the under side and thus curling the leaves in a manner so characteristic of aphid infestation. Their habits are sufficiently near alike to make them amenable to the same treatment. They pass the winter in the egg and adult stage on rubbish and parts of plants infested the previous season. Their bodies are very delicate and for this reason they are held in check by a number of natural conditions; cold, wet weather and late frosts destroying large numbers of them, especially the young. Syrphus-flies, lady-beetles, lace-wings, internal parasites, insectivorous birds and fungous diseases are among their natural enemies. If treated early they can be destroyed by the use of certain well known contact sprays.

Control: Gather up and burn unused portions of plants in the fall of the year as soon as the crop is harvested, thus destroying the eggs, and hibernating adults. Destroy all weeds by frequent cultivation during the summer, and at the end of the growing period, by gathering and burning all that may be present. Practice rotation of crops so as to avoid exposing the new crop to the insects which may have remained in or upon the soil.

In spraying for plant lice care should be taken to apply the spray before the leaves are curled, or first pull off and destroy all leaves which have been distorted and curled by the action of the aphids in such manner as to prevent the spray from reaching the insects. Use an under-spraying attachment or 90-degree elbow so as to direct the spray in an upward course, thus making it possible to reach the under sides of the leaves upon which the insects are located. Use either of the following mixtures:

Tobacco decoction or extract (No. 41 a).

Fish-oil soap (No. 33 b).

Kerosene emulsion (No. 32 a).

Common laundry soap (No. 33 a).

III. Diseases of Beans.

Anthracnose or Pod-Spot. All parts of the plant except the root are subject to attack from this fungous disease, although it is most conspicuous and readily seen upon the pods. Nearly every one is familiar with the spots upon beans, especially the "wax pod" varieties. These appear first as small brownish or purple discolorations and, as the disease develops and spreads, the circles become darker, sunken, and covered with reddish masses of spores, by means of which the disease spreads from plant to plant. Neighboring spots

merge, and thus large areas of irregular, sunken patches, often involving the greater surface of the pod, may result. The fungus grows by sending fine root-like filaments into the cells of the tissue, which often reach the beans within the pod, and thus they become a means of carrying the disease from one crop to the next when used as seed.

Control: The most important measure in the prevention of Bean Anthracnose is the selection of seed from plants free from disease. It is not sufficient to plant seeds apparently sound, but these should have been grown in patches in which the disease did not occur. Should the disease develop, all affected plants should be removed from the patch and burned as soon as the characteristic symptoms are first observed. Since the spores of the fungus are sticky while wet it is best to keep out of the patches when they are covered with moisture. Burn all rubbish in the field, and practice crop rotation.

Spraying with Bordeaux mixture (42 c) is advised when the disease appears early, and when thorough application can be made,—removing all infected plants first.

Bean Blight. This is a bacterial disease common in some sections of the State and affects the leaves, stems and pods of garden, field and lima beans. The first sign of the disease is the appearance of irregular, water-soaked patches on the foliage, which become brown and papery during dry weather. It is believed that diseased seed is the source of the early infection, but later infections may result through injury to any of the green parts.

Control: It is not known that any treatment by spraying will prevent this disease. The measures recommended for the control of *bean anthracnose* are the only means to suggest to check the spread of bacterial Bean Blight.

Powdery Mildew. This fungus is distributed throughout the world and has been found growing upon several hundred species of plants. It often becomes a nuisance on beans, peas and vetches, during wet weather, especially in late summer. The stems, leaves and pods are the parts affected, over which the fungus forms a dense, white growth. When the mildew attacks young plants the crop is usually a total loss, if not promptly treated.

Control: Dust the plants while wet with a fine sulphur or sulfur and lime (No. 46)), or spray with potassium sulphide (No. 44). Dilute lime-sulphur solution (34) or (35) is a specific against mildew.

Rust. This fungus occurs upon the bean and other related species of plants, such as the cow-pea. It appears on the leaves late in the season, especially on plants making poor growth, destroying the foliage, causing early maturity of the crop, and lessening production. There is a decided difference in the susceptibility of different varieties to this disease, both among dwarf and pole sorts.

Control: (Same as for BEAN ANTHRACNOSE.)

BEET.

I. *Chewing Insects.*

Blister-Beetles. Several species of insects known as blister-beetles or "old-fashioned potato bugs" belonging to the genus *Epicauta*, feed in the adult stage upon the foliage of a number of plants among which are beets, potatoes, carrots, chrysanthemums and alfalfa. They are slender beetles, about three-fourths of an inch long, and of a uniform black or gray color, or yellowish with two black stripes on each wing cover.

In the larval state these insects are beneficial since they feed upon the eggs of the locust (grasshopper) and other destructive insects. The females deposit eggs on the ground in clusters of four or five hundred in localities frequented by locusts (grasshoppers). In ten days the small white larvæ hatch and bore into the egg pods of the locust upon which they feed. After several successive molts during growth, they burrow into the ground, forming pupæ, in which condition they pass the winter. The adult insects issue from the ground in the early summer.

Control: In small patches the beetles can be gathered in pans early in the day, especially from such plants as asters, chrysanthemums and other plants in blossom or with delicate foliage, which would be injured by the application of arsenical sprays. In large patches they can be driven by whipping into small windrows of straw, the latter to be set on fire when the insects have taken shelter beneath it. The best remedy is an application of an arsenical spray, applied thoroughly and early such as Paris green (No. 26 a) or five pounds of arsenate of lead (No. 27 b) in fifty gallons of water.

III. *Diseases of the Beet.*

Leaf Spot. The beet leaf spot is a fungus of common occurrence, the red garden beet being seldom wholly free from it, although many varieties are apparently so resistant that the disease is not a very important one in garden and truck work. The spots on the leaf are at first very small brown areas with reddish purple borders. As the spots enlarge they turn ashen gray, merge, and may involve almost the entire leaf, which dies and drops off. The outer leaves are the first to die and new leaves are formed from the bud; thus the crown may be considerably elongated at the expense of the root as a result of this disease.

Control: Destroy remains of the former season's crop. Practice crop rotation. Spray the plants early with Bordeaux mixture (No. 42 a) and repeat every ten days or two weeks until the beets are three-fourths grown.

Scab. (See under POTATO.)

CABBAGE AND CAULIFLOWER.

I. *Chewing Insects.*

The Cabbage Looper. This is a more or less striped pale green "worm" about one and one-half inches long at maturity. The common name of "Looper" or measuring worm, given this insect in the larval stage, describes its characteristic method of crawling by the advancement of one end of its body at a time, during which it is folded upon itself like a hoop. It is an important pest of the cabbage family. The adult is a dull green moth measuring about one and one-half inches across the expanded wings and flies actively at dusk and on dull cloudy days. The eggs are laid upon the plants and from these hatch the larvæ, which feed greedily upon the leaves. On the under side of the leaf it pupates in a brown spindle-shaped, silken cocoon, from which the adult emerges after a few weeks. There are several broods each season and the insect passes the winter as a pupa.

Control: (Same as for CABBAGE WORMS.)

Cabbage-Worms. These insects are responsible for more injury to the cabbage crop than, probably, any other. There are several species attacking cabbage and related plants, the most important of which is the imported cabbage-worm. The damage done by these pests consists in riddling the leaves with holes, which results in the loss of sap and the drying out of the plants, thus retarding development, and reducing the yield of the crop. Do not be misled by the consideration that since the injury is done to the outer leaves this does not hurt the head, which is formed from the inside and is not reached by the worms. The leaves of the cabbage are as important to the growth of this plant as are those of a tree to its life and health.

The cabbage worms are the larvæ, or caterpillars, of small white butterflies with more or less black markings on their wings. They measure about one and one-half inches from tip to tip. They may be seen flying very early in the spring, and during summer when they lay their yellow eggs on the plants. These hatch into small green velvety "worms," which lie flat upon the surface of the leaves when feeding. When full grown they measure one and one-half inches in length. They form uncovered pupæ on the under side of the leaves,

from which they are suspended, remaining in this stage a few weeks, at the end of which time the adult butterflies emerge. There are several broods each season, and the insects hibernate in the pupal stage.

Control: Almost all insects are subject to attacks from other insects, fungous diseases, and larger animals. Cabbage worms are readily devoured by birds and toads, which should be protected.

Since cabbage worms winter over as pupæ on remnants of plants in the field, it is desirable to destroy such remnants as soon as possible after harvesting. There are few insect pests more easily destroyed than cabbage worms and no grower is justified in permitting his crops to suffer from them. The most convenient and effective insecticide for use on a large scale is an arsenate, applied either as a dust or spray. One pound of Paris green, or three pounds of powdered arsenate of lead, mixed thoroughly with forty pounds of dry air-slaked lime, applied lightly upon the infested heads, preferably when damp with dew, will readily kill them. In the dry state this can be applied by means of a "blow bun" or from thin cloth sacks in which the dry mixture can be tied, and this shaken or beaten over the plants until enough sifts through the cloth and settles on the leaves. A fine tin sifter will serve the same purpose.

These poisons can also be applied in the form of spray (see No. 26 a, and 27 a). Because of the smoothness of cabbage leaves they are not favorable to the ready adhesion of ordinary liquids, so that two pounds of resin soap (48) or two or three gallons of resin lye mixture (No. 47) should be added to each fifty gallons of the spray liquid.

Kerosene emulsion (32 a) or fish oil soap solution (No. 33 b) or ordinary soap solution (No. 33 a) or even air-slaked lime dusted freely upon the cabbage worms, or hot water poured upon them with a sprinkler will destroy them. Where a few stalks only are grown they can be kept free from injury by hand-picking.

It is a matter well understood by growers of garden and truck crops everywhere that no poisons are to be applied shortly before harvesting to the parts of plants used as food. Thus lettuce, spinach, celery, and other like crops cannot be treated with poisons except while small, or a considerable time before they are full grown. Neither is there any occasion to do so, since such crops are seldom, if ever, attacked by chewing insects which could be destroyed by internal poisons at that time. On such plants chewing insects should be destroyed by the use of materials which are non-poisonous to humans, such as Pyrethrum or Buhach (No. 40), or Hellebore (No. 31.)

Cut-worms. These stout-bodied, soft and brownish-black or grayish caterpillars are the larvae of a large family of moths or "millers" known as Noctuids or Owlet moths, because of their habit of flying at night, and also because their eyes shine like those of the owl in the

presence of light. The larvae are also most active during the night. They live normally in the sod, a little less than one year, feeding upon the tender growth of grass and weeds. It is consequently natural that they should turn their attention to the crop following sod when this is plowed under. This accounts for the severity of cut-worms on crops following sod in the rotation. They attack cabbage, tobacco, beans, tomatoes, corn, and many other crops. The characteristic manner in which they injure plants is suggested by their name, as they usually devour a section of the stem at, or immediately beneath, the surface of the ground, thus cutting it off as with an edged tool. Sometimes they feed upon the leaves or stem which they may drag into the opening of their burrows in the ground.

The adult moths are usually brownish or grayish in color with hind wings a little lighter, and measure from one to two inches across when the wings are fully expanded. They begin to appear in May and continue until November. They lay their eggs in grassy or weedy places where the young larvae feed, and may pass the winter in either the larval or pupal stage. It is the larva which passes the winter in the partly grown condition that attacks the plants so vigorously in the spring, with the consequent destruction of the crops.

Control: Because the eggs are laid on grass and weeds no crop liable to serious injury by cut worms should follow sod. Keep down all weeds on lands to be planted to such crops. Plow in the fall, and cultivate the ground liberally before setting out the plants. The cut-worms feed mostly greedily in the early spring; hence the later plants will be least injured.

The fondness of these insects for sweets in both the larval and adult can be taken advantage of in killing them with poison baits; as, for example, by the use of the poison bran mash (No. 30 b). This is distributed in little piles or pellets in the rows where the plants are to grow, in the evening several days before the plants are set out. The cut-worms, being attracted by the sweet odor, will feed upon the mash in preference to anything else and be poisoned.

Green clover, soaked in water in which paris green has been mixed, is also a valuable bait, (No. 30 a). Stir the clover in the liquid thoroughly so that all parts will be submerged and covered with the poison. Scatter this about the fields to be planted before the crop is set out.

As the larvae spend the day near the plants they have attacked, and can be found ordinarily beneath the surface of the ground, they can be gathered by hand and killed before setting a replant in the same spot. When setting out small patches of any crop the plants can be protected from cut-worm injury by wrapping the base of the young stalk with pieces of paper of convenient size. This method is frequently used in gardens with success.

II. *Sucking Insects.*

Aphids. (See under bean).

Cabbage Root-Maggot. Cabbage root-maggots are small white "worms" that scrape and eat the outer surface and burrow into the interior of the stem and roots of cabbage, cauliflower, kale, turnips, radishes, mustard and some other cruciferous plants. They are responsible for a great amount of damage to these crops. The infested plants become of a pale bluish color, fail to grow, and suddenly wilt, especially during dry weather.

The maggots are the larvæ of a small two-winged insect, very much resembling the common house fly in size and appearance. The adult female lays her eggs about the beginning of May at the base of a plant. These hatch in from five to ten days and the young immediately begin to feed. They are without legs and often find difficulty in reaching the plant or entering the hard stem. When they become full grown they leave the root or stem and pupate in the ground about an inch beneath the surface, spending a few weeks in this stage, at the end of which time the adult flies break out of the pupal shells and crawl out of the ground. There is a second brood in June.

Control: The known measures for the control of the cabbage maggot are both preventive and curative. Among the former are the use of mechanical barriers, such as paper discs about the plant. These discs may be about three inches in diameter and split from one side to the centre. They can be cut very easily by the use of a tool made for the purpose, and any thin grade of cheap cardboard or tarred paper can be used. This is placed about the plant at the time of setting and pressed down firmly upon the ground. Pressing the ground firm and hard about the stem immediately after planting will be beneficial, since it will in a measure prevent the young maggot from burrowing in the ground near it. A handful of tobacco dust sprinkled in the hole at the time of planting, or a spoonful of sand previously sprinkled with kerosene oil will often prevent infestation by acting as a repellant to these insects.

Destroy all remnants of plants after the crop has been gathered in the fall so that the insects may not breed or be carried over winter in them. Destroy all weeds so far as possible, especially wild mustard, seeding turnips, etc., on which the insects feed and winter.

Infested plants may be saved by the immediate application of one of the following materials—carbon bisulphide injected into the soil near the plants, or carbolic emulsion (No. 36). For use dilute one part of this emulsion with fifteen parts of water. Treat infested plants by hollowing out the earth slightly about the plant and applying the dilute emulsion freely. (See Plates Nos. 21 and 22.)

Equal parts of common salt and nitrate of soda applied either in solution or undissolved about the stalk will also kill the maggots upon the roots. In fact nitrate of soda alone is very valuable for this purpose not only on account of its insecticidal value, but also as a fertilizer, since it stimulates the plant to increased growth which thus outgrows the injury already sustained from the pests.

Harlequin Bug. This Southern insect attacks many garden vegetable crops. Harlequin bugs are sucking insects provided with a stout beak or proboscis which they insert into the tissues of the plant and suck out the sap, causing the leaves to wilt, turn brown, and die.

The adults, gayly colored in black, orange and yellow, are about one-half inch long, and emit a very disagreeable odor when crushed. The eggs are laid in rows of six on the under side of the leaves. The young when hatched resemble the adults in every respect except size, and their absence of wings. They hibernate during the winter in the adult form in bunches of weeds, straw, piles of rubbish, and neglected fence corners.

Control: Clean, careful cultivation is essential to success in controlling the harlequin bug where it is known to do damage, as they cannot be destroyed by spraying with internal poisons, since they do not eat the substance of the plant. Clean up, and keep clean the garden and truck patch. Put out piles of straw in the field, and when they have collected there burn them. Plant a trap crop of a few plants of mustard or any other they seem to attack most severely, early in the spring, and destroy the pests on these when they become infested, by spraying with pure kerosene. They can be shaken by hand from plants they infect into shallow pans containing tar or kerosene.

The young bugs (nymphs) can be destroyed by spraying with a contact insecticide, such as ten per cent. kerosene emulsion (32), but this strength unfortunately is likely to injure some vegetable foliage. It can, however, be used on cabbage plants with safety. The sooner after hatching the young nymphs are treated the better will be the success. Should infestation by adult bugs become general on some plants or parts of a patch, spray these with pure kerosene, and thus destroy the bugs as well as the plants to prevent the further spread of the pests.

III. Diseases of Cabbage.

Black Rot. This bacterial disease of cabbage and some related plants has been reported from several sections of this State and is, without doubt, the most destructive and least controllable cabbage disease. Infection starts at the margin of the leaves, which turn yellow and later brown and black. The veins of the leaves become

black and decay. The disease progresses inward toward the stem, and subsequently out again to the infected leaves. Leaves attacked in this manner turn black and fall off prematurely.

Control: Young infected plants should be gathered immediately and burned. When a single leaf only is infected the entire plant should be removed and destroyed by burning. It has not been found possible to check this pest by spraying with a fungicide.

The bacterium causing the disease lives in the ground several years. Thus crop rotation is the best means of eradicating the organism. Do not plant cabbage, cauliflower, collards, or other related plants in ground on which any of these crops were grown and infected with black rot within the few preceding years. Before sowing, soak cabbage seed in either a solution of corrosive sublimate one part to one thousand of water for fifteen minutes, or in formalin, one part to two hundred of water for twenty minutes.

Club Root. This is a destructive disease affecting cruciferous plants. It causes swellings and malformations on the roots varying from slight nodules on the smaller rootlets to extensive enlargements on the main roots. The leaves of affected plants show decided evidence of unthriftness, and later wilt and die. It is caused by a slime fungus, and is known to affect cabbage, cauliflower, rutabaga, radishes, turnips, certain mustards, and some weeds. In its early stage the enlargements upon the roots may be confounded with injury caused by the cabbage root maggot, but with which it has no connection whatever.

Control: Since the organism producing this disease gains entrance to the plant through the soil, where the germs remain many years, the best results in controlling it have been had in crop rotation. Destruction of infected plants, rubbish, and cruciferous weeds, and treating the soil with a dressing of lime at the rate of one hundred bushels per acre every few years, are also recommended.

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VOL. II.—No. 5.

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TRUCK CROPS.—PART 2

SEPTEMBER, 1912

H. A. SURFACE, D. Sci., *Economic Zoologist,*
Editor

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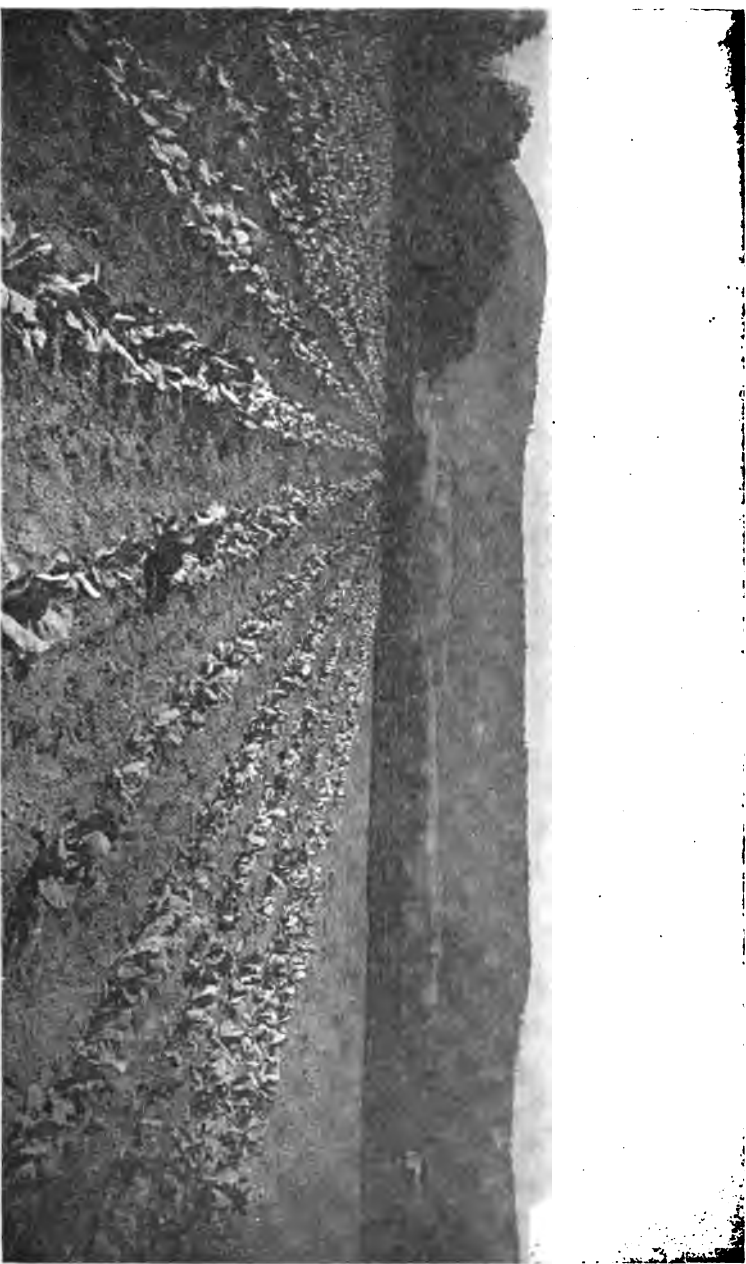
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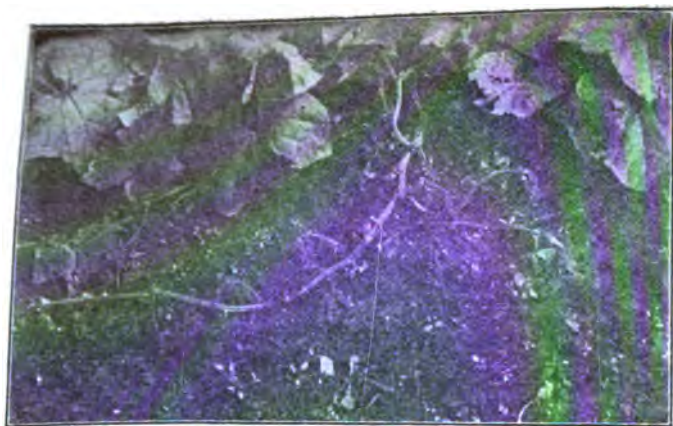
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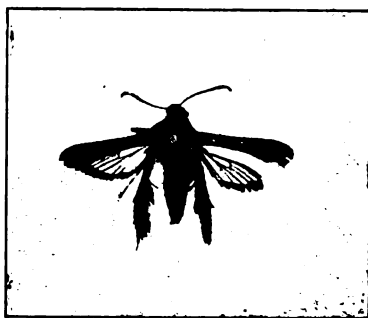
No. 23. Radishes infested with Radish root worm. Collected and photographed in office of H. A. Surface, State Zoologist.



No. 24. Cucumber plant wilted by effects of larvae of the Striped cucumber beetle, feeding at its roots. Collected and photographed by H. A. Surface, State Zoologist.



No. 25. Root of vine shown in Plate No. 24. The larvae of the Striped cucumber beetle have eaten away the entire coating of the root.



No. 26. Moth of Squash borer





No. 27. Squash plant just attacked by borer, showing borer dust on the outside.



No. 28. Squash plant almost killed by borer at point where lines "a" and "b" cross.

CELERY.

I. Chewing Insects.

Papilio Caterpillar. The larvæ of the Swallow-Tail Butterfly (*Papilio* sp.) are sometimes found feeding on the leaves of certain garden crops, such as celery, parsnips, carrots, etc. These caterpillars are beautifully colored with green, black and yellow, and are very conspicuous, although neither birds nor domestic fowls will eat them because of their disagreeable odor. The adult is one of our common butterflies.

Control: As this is a chewing insect, and feeds upon the foliage of plants, it is easily destroyed with arsenate of lead (No. 27 a). Other arsenicals as recommended for chewing insects will also be effective. However, neither celery nor other plants used as human food should be sprayed with such poisons, except when young, since a trace of this poison would likely remain upon them if they were treated within a few weeks of the time of harvesting. In treating celery for chewing insects it is, therefore best to use insect powder, Buhach, or white hellebore (slug shot) dusted upon them.

Flea-Beetles. (See under BEAN).

II. Sucking Insects.

Aphids. (See under BEAN).

III. Diseases of Celery.

"Damping-Off" The term here used to designate this fungous disease has become common, no doubt, because of its characteristic effect upon young plants. The part first affected is ordinarily the stem at or near the surface of the ground. The tissues become water soaked, lose their stiffness and the plants fall over. Nearly all garden vegetables are subject to this disease.

In the later stage of growth it may attack all parts of the plant, including the roots. On potatoes, radishes and beans it causes a characteristic rot. It is most conspicuous and destructive as a disease of seedlings in the forcing beds in green houses.

Control: No certain effective method of preventing this disease is known. All that can be done towards its control consists of the practice of general sanitary measures. Provide good drainage for the upper layer of the soil. This may be done by placing the upper layer upon a layer of sand or charcoal through which the superfluous water may drain freely. A little lime added to the soil is useful in correcting acidity, which condition is favorable to the growth of the fungus. Proper ventilation is important.

Celery Blights. Two distinct diseases known as "Early Blight" and "Late Blight" cause injury to celery. The Early or Summer Blight produces large irregular spots on the leaves and appears during the summer. It is quite common in moist localities but does not usually injure the crop very seriously. The Late Blight is characterized by smaller diseased areas on the leaves covered with little black spots. Its development is also furthered by wet weather. The outside leaves become *affected first* and wilt, causing a stunting of the plant. It also affects celery in storage.

Control: Spray the plants in the field with Bordeaux mixture (No. 26 b) or when plants are nearly grown with copper carbonate solution (No. 43). Celery affected in the field should not be stored for any length of time, but put upon the market as early as possible.

CLOVER.

I. *Chewing Insects.*

Clover Root-borer. This insect, accidentally imported from Europe, is known to infest clover in several sections of this State. The injury is done by the larvæ which feed upon the interior of the main roots, forming tunnels extending through their entire length. Affected plants are apt to break off at the crown and die. Mammoth clover suffers most from their attacks. Common red clover is also seriously damaged, but Alsike is considerably less subject to damage by the clover root-borer. Fields which have been cropped for one or more seasons are the ones usually found infested, since the roots of the clover during the first year of growth seem too small to tempt the root-borer to attack them.

The clover root-borers are the larvæ of small reddish-brown beetles, less than one-eighth inch in length. They pupate in the tunnels in the roots formed during their development sometime during the latter part of summer, and become adult beetles by fall. The winter is passed in the tunnels in the adult stage and the eggs are laid in the spring. Migration to new fields takes place in May.

Control: Since the root-borer never attacks the clover plants until they are one year old, we have here an effective means of control in the short crop rotation. Clover sod in the vicinity of infested areas should be turned under after the first crop of hay has been taken from the field. Infested fields can be cleaned up by plowing immediately after cutting and exposing the roots to the drying influence of the sun.

The Clover Leaf-Beetle. The leaf beetle or weevil is an important enemy of clover. It feeds on the leaves of this plant in both the larval and adult stages. The larvæ can be seen in the spring as green

slug-like worms devouring the fresh foliage of clover plants. When fully grown they are about one-half inch in length, at which time they spin beautiful fine meshed cocoons near the surface of the ground. The mature beetles appear in July.

Control: The application of arsenical poisons sprayed upon the infested plants would, without doubt, destroy these insects. Fortunately the larvæ are subject to the attacks of a fungus which ordinarily holds them in check. However, the fungus developing in the bodies of these larvæ unfavorably affects cattle feeding upon the plants, and care should be taken to avoid pasturing fields full of dead larvæ until they have dried up and fallen to the ground.

Clover-Seed Midge. This insect deposits its eggs in the flowers and the larvæ feed upon the seed as it forms. The pest is most detrimental where clover is grown for seed rather than for fodder.

Control: Where these insects are known to occur a good practice is to cut the early crop when in full head and to depend on the second crop for seed. In this way the seed will be practically exempt from attack. Practice fall plowing, use lime or kainit as a fertilizer and sow some crop which requires frequent cultivation.

Locust. The red-legged locust is the familiar "grasshopper" in the State, and often becomes severely destructive in some localities.

Control: Where practicable spray with Paris green (26 a) or arsenate of lead (27 a). Keep turkeys in infested localities.

CORN.

I. *Chewing Insects.*

Corn-ear Worm. The corn-ear worm is known in southern states as the cotton boll-worm, since it there feeds upon the cotton boll and is very destructive to that crop. In this State it is often found feeding on the ripening kernels of corn, especially the sweet varieties. The ears attacked are thus rendered unmarketable as fresh green corn. The "worms" when full grown are one inch and a half in length, of a pale-green color with pink or brown markings. They pupate just beneath the surface of the ground in little cocoons of silk intermixed with particles of soil. There they may pass the winter, or the adult may emerge about two weeks later as a moth. There are at least two broods per year in this State.

Control: Hand picking is the only practical remedy. Infested ears can be recognized readily on account of the premature drying of the silk, and such ears can be opened at the top and the larvæ found and crushed. Fall plowing will destroy the pupæ in the ground directly, or indirectly by exposing them to insectivorous birds. We recommend spraying the corn silk, as soon as it forms, with arsenate of lead (No. 27 a).

Corn-root Worms. Two species of insects belonging to the genus *Diabrotica*, in the larval stage bore into the roots of the corn plant and the lower part of the stalk, beneath the surface of the ground, and are known as root worms. They are slender white larvæ about three-fourths of an inch in length. The injury done by these insects sometimes kills the plant outright, but oftener retards its growth so that it will not mature before the autumn frosts. The Southern Root Worm feeds upon a variety of plants. It bores into the stalks of corn. The adult is a greenish yellow beetle, with six spots on each wing cover. There are two broods each year, and it passes the winter in the adult stage. The Northern Root-Worm feeds upon the roots themselves and may become very injurious where corn is grown in the same ground several years in succession. The adult of this insect is green in color and feeds upon the silk and pollen of corn and on the pollen of other plants.

Control: Rotation of crops is the most effective method of ridding a field of these pests. Clean cultivation is essential. No remedy which can be applied directly is known, but stimulating fertilizers, such as contain nitrate of soda, applied early in the season will enable the plant to outgrow the injury done by these pests.

Cut-Worms. (See under CABBAGE).

Wire-Worms. These are round, slender, yellow creatures, ranging from one-half to more than an inch in length. They have hard glistening, shell-like skins and six short legs just behind the flattened heads. They feed upon the roots of grains, corn and other grasses, also on potatoes, rotten wood, etc. Where they are present in the soil in sufficient numbers when the plants are small they often destroy them by devouring the roots. Replanting seldom results in remedying the evil, as they attack the young roots of the second planting, in turn.

The Wire-Worms are the larvæ of certain species of "Click Beetles" or "Snapping Beetles." These beetles appear quite early in the spring and may be seen flying rapidly in mid-day. During May and June the eggs are laid in grass-land or among weeds. The larvæ hatch in mid-summer and begin feeding on the roots, growing slowly, and requiring from two to three years to reach their full size. They pupate in the fall in little earthen cells in the ground and pass the winter either in these cells or as adult beetles.

Control: It is impossible to prevent injury from these insects by treating the seed before planting. The application of commercial fertilizers will not destroy the wire worms unless applied in excessive quantities, although their use is recommended because of their stimulating action upon the plants, which thus tend to outgrow injury. We have, however, a partial means of protecting crops from the ravages of this pest in fall plowing, crop rotation, and destruc-

tion of weeds. Fall plowing and late cultivation of the soil will destroy the pupæ in the ground at this time. Since they require at least two years to mature, a short crop rotation will practically prevent them from establishing themselves in the soil. By keeping down weeds in out-of-the-way places, they are prevented from feeding upon the roots and growing to maturity in these localities.

The Angumois Grain. Moth. The larvæ of this insect work on wheat, corn, rye, oats, barley and peas, both in the field and on the stored grain. They bore into the kernels and consume the interior, leaving nothing but the thin shell. A single grain of wheat is sufficient to bring one insect to maturity, while three or four often develop in a grain of corn.

The adult moth is a delicate little "miller," much resembling a clothes moth, but somewhat larger, measuring a little more than half an inch across the extended wings. In color they are brownish or yellowish white, with little brown and black markings upon the wings. The eggs of the first generation are deposited in the opening heads of wheat in the field. These eggs develop into mature moths which, in turn, infest the grain before it is harvested. There are several generations during the summer, and the insects continue to breed on grain in the mow or bin as long as the weather is warm. Only the outside layers of stored grain become infested in the barn. If, however, the crop contained eggs at the time of harvesting, these will develop a generation which feed upon the grain in all parts of the mow or stack of unthreshed grain.

Control: Thresh grain soon after harvest, and store in tight bins or sacks. If the grain becomes infested in the bin it should be fumigated with carbon bisulphide, using one pound to every one hundred bushels or one hundred cubic feet of space in the bin. If the grain is not intended for seed, the liquid carbon bisulphide may be poured upon it stored in a tight bin and covered immediately with a wet blanket to prevent the escape of the fumes. Since, however, contact of this liquid with the grain may destroy its germinating power, in fumigation seed the carbon bisulphide should be poured into a shallow pan which is set in a depression on it and the whole covered over as above described. Care must be taken to leave sufficient space between the pan containing the liquid and the covering to allow the escape of the gas. This is done by placing sticks over the pan.

Corn-Root Web-Worm. The adult moth can be recognized from its habit of rolling up its wings while at rest, so that it resembles a small cylinder. The eggs are deposited upon the grass early in spring from which the larvæ hatch and feed upon the stem of roots spinning about them a loose web or tube of silk. Corn planted in fallow or bare ground will not become infested, nor will a corn patch near a grass field.

Control: Ground to be planted with corn should be plowed in the fall and cultivated thoroughly.

Stalk-Borer. This "worm" burrows into the stalk of various plants among them are corn, potato, tomato and large weeds. The stems are broken or cut off and wither. It hatches from an egg laid late in the summer by a dark-colored moth.

Control: Destroy insect by cutting out and crushing it wherever found. Mow all large weeds three or four times per year. Burn stalks of potatoes and tomato as soon as crop is off.

White Grubs. These are the larvae of many species of beetles;—chiefly the "June Bug" or "May Beetle,"—and are of a yellowish white color, with often a pinkish or greenish cast; cylindrical in shape, wrinkled and curved, their bodies end in an enlarged, obtuse terminal bulb.

Control: Same as for Root Web-Worm.

In using carbon bisulphide it should always be remembered that the gas is poisonous if inhaled and explosive if fire be brought in contact with it. Cold weather reduces its efficiency.

COEN.

II. *Sucking Insects.*

Chinch-Bug. Chinch-bugs were reported from several sections of this State during 1911. They attack corn, small grains, and grasses. Injury is done by sucking out the juices from the plant and injecting a poison.

They are small bugs measuring less than one-sixth of an inch in length. Their bodies are black, and wing covers snowy-white, each marked with a dark spot on the outer edge.

There are two generations of the chinch-bug each year. They winter over as adults, hiding in multitudes under rubbish of all kinds, and in clumps of grass. In the spring they come forth and lay their eggs in the grain and grass fields on the roots of plants. From these eggs hatch, in a few weeks, young red nymphs, which feed first upon the roots and later upon the plants above ground. They mature in eight or nine weeks, and then migrate to new pastures. Although supplied with wings, they crawl upon the ground, usually going from grain to corn fields at this time. Here they lay the eggs of the second brood, which is so destructive to the corn crop.

Control: There is no very satisfactory means of controlling this pest upon crops. As they are suctorial insects, the internal poisons are not effective against them. They can be destroyed by spraying with pure kerosene, but this will also kill the plants. However, it is

best to sacrifice in this way a few rows of corn on the side of the field attacked. This will greatly lessen the number remaining to deposit eggs for the second brood.

The most successful means of destroying chinch bugs is by burning over infested areas in the fall after they have taken refuge under rubbish and clumps of grass, just before winter sets in or during winter. All rubbish and litter not burned should be plowed under in the fall.

It is well known that chinch bugs are subject to a fatal fungous disease which destroys myriads of them. It is, however, not wise to depend entirely upon any natural agencies to control this nor any other pest.

Corn Root Aphids. The Corn Root-Aphid is a small bluish-green, sluggish, soft-bodied insect found living on the roots of corn, from which it sucks out the sap. It begins its attack upon the plant as soon as the seeds sprout. It may continue to live upon the roots during the entire season unless the infested plant dies. It multiplies very rapidly and spreads by means of the winged forms which may be born with every generation except the first.

The common red ants of the corn fields, are mutually associated with the root-aphids and are an important factor in their spread. The ants always accompany the aphids, care for them, protect them, and carry their eggs through the winter. They feed, in turn, upon the sweet exudations from the plant lice.

Control: Destroy smart-weed, pigeon-grass, and purslane which the root aphids infest. A short crop rotation, in which two successive crops of corn are never grown on the same area, is the most important means of getting rid of this pest. Fall plowing and deep, thorough, stirring of the soil in the fall and early spring, and maintenance of soil fertility, are valuable adjuncts. The treatment of the seed with repellants has not proven to be beneficial.

III. Diseases of Corn.

Smut. The fungous disease of corn known as Smut may affect all parts of the plant, although it does most damage to the ear. It produces conspicuous swellings which are at first whitish in color, but after the spores mature turn grayish black. These swellings finally break and the masses of spores they contain are spread broadcast by the winds.

Control: Because of the general practice of crop rotation in this State, smut seldom gets a foothold so as to do very much damage to the corn crop. The fungus lives in the soil and may be distributed through manure or compost spread upon fields to be planted to corn in the spring. Manure from smut-infested corn should not be ap-

plied on fields to be planted to this crop the same season. Individual infected stalks should be removed from fields and destroyed and the smut masses or balls should be gathered and burned before the spore capsules burst.

Wilt. The Wilt or sweet corn is a disease of bacterial origin, the affected plants dying by wilting and drying. Leaves first show the signs of infection and die one after the other because the water supply through the stem is cut off. The disease is located within the stalks. On cutting across the stalk of an affected plant the threads or fibro-vascular bundles appear yellow and, later, black in the white pith. A few moments after cutting the stalks a yellow, slimy substance exudes from the ends of these threads.

Control: Only such varieties of sweet-corn as are comparatively immune should be planted in infected sections. Plant seed from a crop known to have been free from the disease. Practice crop rotation.

CUCUMBER.

I. *Chewing Insects.*

Flea-Beetles. As all the Flea-beetles belong to the same sub-family and as their habits, life history, effects and remedies are similar we treat them together. They can be known by their very small size, hard shell, and the enlarged basal segment of the hing leg, together with the fact that they are able to jump suddenly and disappear like fleas,—hence their common name.

They are the first insects in the spring to attack cucumber plants, eating fine round holes in them before the leaves have expanded and consequently inflicting considerable injury. As the leaves grow the holes enlarge and become conspicuous with brown edges.

The larvæ of most species mine leaves, feeding on the fleshy substance between the two outer covers, but they do not effect much damage. The one generally called the Cucumber Flea-Beetle prefers potato leaves to those of Cucumbers.

As they are biters or chewers they can be killed by the arsenates. Arsenate of lead (No. 27 b) will destroy them. Bordeaux mixture (No. 42 a) acts as a repellant besides being useful as a fungicide or remedy for plant diseases. They can be killed by the thousands by the use of the tarred board. This consists of a thin board nailed on a cross pole. Over it tar or pitch is to be smeared. One person carries this board by the pole or handle with the tarred side toward the plants, and another person from the windward side of the row brushes the insects toward it. They strike it and are killed.

Squash Vine-Borer. The insect or so-called "worm" that bores in the stems of the squash and pumpkin is the larva of a moth known

as a "clear-wing" because it has a space in its hind wings that is clear and not covered with scales. The adult moth measures over an inch in extent of wings from tip to tip, and has the front wings covered with dark green scales. There is a conspicuous tuft of red, white, and black hairs on each hind leg which is characteristic and renders this moth easily determined. (See Plates Nos. 26-28.)

It flies by day, as do all the Clear-wings, and at night remains quiet on the leaves of the plant its larvæ infest. On this account it is easily found and killed at night by using lanterns. It does not fly into lamp traps. In its flight it resembles a wasp. The moth passes the winter in the ground, and appears in this latitude about the last of June. It lays its eggs singly, either on the vines or on the stalks of the leaves. The favorite place is toward the base of the vine, but we have found them at the top of the leaf stem. When the larva hatches it eats into the interior of the vine or the hollow leaf-stem and follows the latter down and enters the vine. The small hole that it makes can be seen, and generally fine borings or dust (excreta) can be seen at this hole. Their presence in the vine can first be detected by the presence of the dust at the small hole. This mass gradually becomes larger and indicates their presence. (See Plate No. 27.)

Control: Because it is an internal feeder it cannot be killed by an insecticide. It should be cut out with a sharp knife, cutting lengthwise of the vine, and dust rubbed on the wound to facilitate healing. The vine should be covered at intervals of a few feet with damp earth over the base of the leaves so that roots can be formed there. After the new roots are formed the vine will continue to grow, even though it may be cut off entirely at its base.

Plant early varieties of squash such as the "Scallop" and "Crook-neck," to serve as trap crops. These will receive the eggs and larvæ and can then be destroyed by burning.

The Twelve-Spotted Cucumber-Beetle. The adult of this insect is a greenish-yellow beetle, with six black dots on each wing cover. It is very common on a great many kinds of plants. The adult beetle feeds on foliage or blossoms, and the larva feeds on the roots of plants. It pupates in the ground and remains there during the winter. There are two broods each year, the adults of the second brood appearing during the first half of August.

The affects of this insect, the remedies to be employed, and its enemies, are the same as those of the next species.

The Striped Cucumber-Beetle. This is one of the earliest and most destructive insects attacking cucurbitaceous plants. It injures all species of plants of this family as well as of some others. The beetles are about one-fourth of an inch long, and are yellow, with two black stripes extending lengthwise on each wing cover.

They appear on plants by the first of June, or as soon thereafter as the young plants come above ground, and commence at once to eat ragged holes into the leaves and even to chew off the young stems. There are two broods which overlap, and are thus not clearly distinguished. In central Pennsylvania the second brood commences to appear about the second week of August. The adults feed on the leaves and tender vines and lay their eggs in the ground by the roots. The larvæ feed on the roots and often cause the plants to wither and die quickly without apparent cause. (See Plates Nos. 24 and 25.) If the earth is carefully removed from around the wilted plant the small white "worms" may be found and the rootlets and soft outer portion of the roots will be eaten away. The pupate in the ground and hibernate as adults.

Control: Cover the plants with netting for protection. The material used in covering must be of finer mesh than ordinary mosquito netting, since the beetles can pass through this too readily. Coarse cheese cloth is probably as good as any. Cut the netting into squares of proper size. Stick into the ground both ends of two pliable sticks bent into semi-circles and crossed at right angles at the top like the central wickets of a croquet ground. Cover them with the netting and place loose earth on the edges all the way around to hold it down. Another and quicker method is to incline a single stake over the plants and push or drive it into the ground. Over this place the netting and cover the edges with loose earth.

Another method of covering plants consists in tacking netting around three sides of two endboards and attaching a stake to each to hold it upright when pushed into the soil. This gives a box-shaped cover with only two ends of wood, the top and two sides being netting.

With all kinds of netting it is essential that the meshes be ^{small} enough to keep out the insects, and that the edges be ^{covered} with earth so the insects will not crawl beneath them.

A third and still quicker, and therefore more economical method, ^{is} simply to place the netting loosely and unsupported over the plant, and fasten the edges down with the loose earth. It should be pulled up at the middle once about every three days in order to relieve the pressure on the plants, but if it does not rain on the earth and fasten it down the plants will exert sufficient pressure to support the netting for themselves. After a few weeks it can be removed and stored for another year.

Dust the plants with Paris green mixed with air-slaked lime (No. 26 b). Air-slaked lime and turpentine acts as a repellant. Dust with finely powdered tobacco or powdered tobacco and hellebore. Put an abundance of powdered or refuse tobacco about the stems in the soil to keep the insects from laying their eggs in the soil where the young hatch and feed upon the roots.

II. *Sucking Insects.*

Aphids (See under BEAN).

Stinking Squash-Bug or Stink Bug. The adult squash-bug is about five-eighths of an inch in length and one-fourth inch wide, with antennæ half the length of its body. The head and back of the body and wing covers are greenish or reddish brown, while the lower side and abdomen are green, banded with yellow. The legs and antennæ are long and slender. The suctorial beak is very long, sharp and slender, and when not in use is folded upon the ventral side of the body and reaches to the base of the hinder legs. They emit a very disagreeable odor when handled. They feed on a variety of plants toward the middle and latter part of summer, in both the nymph and adult stages. The injury to the plants results from the poisonous saliva which they inject into the tissues, as well as from the loss of sap. The infested portions wither, crumple and die.

The eggs are laid on the leaves of plants, usually on the under side. In about two weeks the young nymphs hatch. These nymphs resemble the adults but are broader in proportion to their length. They do not develop wings until after reaching full size.

Control: Hand picking or shaking the bugs into a pan containing a little kerosene is probably the most practicable means of holding these insects in check. The adults can not be destroyed by spraying with any material that will not at the same time kill the plants. The very young nymphs may be destroyed by spraying with kerosene emulsion containing eight or ten per cent of oil (No. 32 a or b). Destroy their food plants as soon as the crop is harvested, thus starving the immature bugs. Seek and destroy their egg masses. When they cluster on a few leaves spray them with pure kerosene.

III. *Diseases of Cucumber.*

Downy Mildew. This is one of the most important diseases of the Cucumber. It attacks most of the members of the Cucurbitaceæ or Gourd Family, affecting also cantaloupe, watermelon, squash, pumpkin and gherkin. The effect of the disease upon the host is shown by yellow spots upon the leaves which enlarge and run together involving the entire leaf so that it shrivels up and dies. The older leaves are first affected and the disease spreads out toward the growing tip. Affected fruits become mis-shapen and are unsalable.

Control: Spraying with Bordeaux mixture made after the 5-5-50 formula (No. 26 c), is known to control the disease. Begin the treatment before the disease makes its appearance, spraying the vines once every week or ten days until six or seven sprayings have been applied.

EGG-PLANT.

I. *Chewing Insects.*

Flea-Beetle. (See under *CUCUMBER.*)

Cut-worms. (See under *CABBAGE.*)

Colorado Potato-Beetle. (See under *POTATO.*)

Blister-Beetle. (See under *POTATO.*)

II. *Sucking Insects.*

Aphids. (See under *BEAN.*)

III. *Diseases of Egg-Plant.*

Wilt. The sudden wilting and drying up of leaves and stem of egg plants should be regarded with suspicion if this cannot be accounted for by some mechanical injury. Egg-plants, potatoes and tomatoes are subject to a germ disease causing these symptoms. When potato vines are affected there is a blackening of the fibro-vascular system of the tubers which may lead to rotting.

Control: Rotation of crops is the only known means of preventing infection. Do not grow egg-plants or potatoes in ground where wilt has been serious during the previous year. There is no known remedy for plants after once infected.

Stem Blight. This disease has much the habit of the damping-off fungus described under that head in the treatment of Plant Diseases of Cabbage in this Bulletin. It attacks young seedlings at the point in the stem just above the ground. This portion becomes water-soaked, shrivels up, and the plant falls over and dies.

Control: Same as for *Damping-off*, discussed under *CABBAGE.*

KALE.

(See under *CABBAGE* and *CAULIFLOWED.*)

MELONS.

I. *Chewing Insects.*

Flea-Beetles. (See under *CUCUMBER.*)

Striped Cucumber-Beetle. (See under *CUCUMBER.*)

Squash Vine-Borer. (See under *CUCUMBER.*)

Twelve-Spotted Cucumber-Beetle. (See under *CUCUMBER.*)

II. *Sucking Insects.*

Aphids. (See under *BEAN.*)

III. *Diseases of Melons.*

Anthracnose. This disease effects the leaves and fruits of most of the cultivated cucurbits. Brown spots are formed on the leaves, while water-soaked sunken spots develop on the fruit, the whole of which may rot in time.

Control: Spray with Bordeaux mixture (42 a) as soon as the vines begin to develop and repeat frequently.

Blight or Wilt. This is a bacterial disease which attacks cucumbers, melons, pumpkins, and squash. The disease is distributed by insects, and as it develops, the entire plant may be come involved, the wilting taking place without any apparent cause. If a cross section of an effected stem be made, one sees that the sap tubes contain a milky, stringy mass which is made up of the bacteria.

Control: Spray with yead arsenate (27 a) or Paris green (26 a) to act as a repellant to biting or chewing insects. A thorough spraying of lead arsenate is to be preferred as it is more adhesive and will remain longer on the vines. Practice crop rotation. Remove and burn acected parts promptly.

OATS.

I. *Chewing Insects.*

Grasshoppers. These pests appear only occasionally in sufficiently large numbers to do damage to crops in this State. They feed upon grains and grasses generally. There is but one generation each year, the young hatching from eggs in May or June. When first out of the eggs they are so small as easily to escape detection, but as they grow larger they require more food and their work becomes noticeable. When full grown they lay their eggs in pods in the soil, selecting dry situations in sod when possible. Each pod contains from twenty to thirty eggs and the exterior of the egg-pod or case is covered with a water-tight layer of dried mucus, thus protecting it from the rigors of winter. The egg masses are placed beneath the surface of the ground at a depth equal to the length of the mother's abdomen.

Control: Fall plowing is the most efficient means of destroying grasshoppers, as this practice either buries, or breaks open the egg pods, and exposes them to the moisture in the ground, or makes them accessible to birds.

Poisoned baits, such as recommended for cut-worms, can be used to kill grasshoppers. Paris green (No. 30 b) or criddle mixture (No. 30 c), should be spread in the locations where the grasshoppers feed.

II. *Sucking Insects.*

Thrips. Everyone who has sojourned in the agricultural districts of Pennsylvania during the month of July is familiar with the appearance of the grass thrips or oat thrips or "oat midges" as they are commonly called. They are very small, brownish black, slender creatures and often annoy persons enjoying the cool shade under trees near oats patches in mid-summer. They attack oats, timothy, corn and other grasses.

They feed on the sap which exudes by scraping the epidermis from the tender young leaves. They are therefore not true suctorial insects. neither can they be properly classified with the chewing insects. Scars from these scrapings show after the leaves become fully unrolled, when they appear as blackened lines lengthwise on the leaves. Oats which are advanced and have headed out before attacked show less injury.

Thrips thrive best in hot dry weather, and moisture usually stops their depredations.

Control: The only preventive measures known are clean culture and destruction of rubbish all over the farm.

III. *Diseases of Oats.*

Rust. The Common Rust of grains, which attacks oats, wheat, barley, and a great many varieties of our ordinary grasses, is probably the most important species of the Rust Family. It produces numerous pustules of the black or red rust condition on the entire surface of the plants affected, often covering the leaves with the reddish, powdery spores. It is augmented by prolonged rainy weather, and at such times often badly injures the crop.

Control: No treatment is possible except crop rotation and the selection of varieties found to be relatively resistant.

Loose Smut. This fungous disease of oats and wheat is more or less common wherever these crops are grown. It attacks the kernels and also the glumes or husks so that the grains are converted into a loose mass of sooty spores.

Infection takes place by means of spores of the disease on the seed which germinate at the same time as the seed oats in the ground.

Control: The hot-water treatment has been found to give good results in destroying the spores of loose smut on both oats and wheat. This consists of immersing the seed for ten minutes in water at a temperature of 132° Fahrenheit. Seed can be put into a basket, per-

forated tin kettle, or sack made of loosely woven material. In practice it is found desirable to throw the seed into cold water. The smutted grains will float on top and can be skimmed off. Next the seed should be dipped in warm water of about 110° to 120° F., in order that the temperature of the hot water may not be reduced to any considerable extent. Finally the seed is to be immersed in hot water at a temperature of not less than 130° F., and kept there for ten minutes.

Immersing the seed in a solution of formalin (No. 45 a), for about ten minutes and then spreading it out on heaps and covering for two hours is also effective in destroying the germs of smut. After two hours the grain should be spread out and dried as rapidly as possible. Treated seed should be kept away from further sources of infection until time of seeding as it is subject to reinfection.

ONION.

I. *Chewing Insects.*

Cut-worms. (See under CORN.)

II. *Sucking Insects.*

Onion Maggot. The Onion Maggot resembles the Cabbage Maggot in appearance and life history. The adult is a two-winged fly which deposits its small white eggs on the bulbs or lower leaves of the young plant. In about two weeks the young hatch and bore into the bulbs, consuming the entire bulb, when they pass on to another. The maggots are of a dull white color, pointed at the front end, and when mature about a half inch in length. They pupate in the earth near the host plant, and the adults emerge about six weeks after the eggs were laid. There are at least two generations each season.

Control: Important factors in the control of the onion maggot are crop rotation and the destruction of rubbish. Infested plants can be treated with carbon bisulphide, a small quantity poured into a hole near the infested plant, carbolic emulsion (No. 36) or nitrate of soda and salt, as recommended for cabbage-root maggot.

Onion Thrips. This species of thrip is often very injurious to onions, which they sometimes attack in great numbers. They injure the leaves by puncturing them with their beaks, leaving everywhere small, grayish or yellow dots. Seriously infested onions turn gray, then yellow, and lose their vitality.

Control: Spray with tobacco decoction or extract (No. 41 a) to which two per cent. of kerosene emulsion (No. 32) has been added.

III. Diseases of Onions.

Onion Mildew. This is a downy mildew appearing on onions late in June, and especially affecting plants grown for seed. The affected leaves become covered with a violet, downy growth, which later turns to a lighter colored mold. The affected areas collapse and dry, thus giving the plant a ragged appearance.

Control: Spraying with Bordeaux mixture (No. 42 a) two or three times before the middle of June is recommended. In order to cause the spray to adhere to the foliage add two pounds of resin soap or two or three gallons of resin-lye mixture (No. 47) to each fifty gallons of Bordeaux mixture.

After the disease is present in young onions it may be checked by gathering and destroying the affected tops. Recovery in the case of older onions is seldom. Crop rotation and the burning of rubbish is necessary to eradicate the disease.

Smut. This disease is characterized by the appearance of dark spots just below the knee of the first leaf of the young plant soon after growth begins. Other leaves become similarly infected and the disease may cover the entire plant. The affected leaves wither and die and the fungus upon them ripens masses of spore powder. This is washed into the soil, which harbors the infection. The spores may also be disseminated through the agency of the seed.

Control: Practice crop rotation. Soak the seed for fifteen minutes in a solution of one ounce of formalin in two gallons of water or transplant them from a bed of soil free from the fungus in which they have been grown. Treating the land by drilling in with the seed a mixture of sulphur and lime (No. 46) is recommended. Do not plant in soil that was previously infected.

PEA.

I. Chewing Insects.

Pea-Weevil. The pea-weevil differs from the bean-weevil in size, being larger, and, in that only one works in a single pea at a time; also, it does not continue to work in dried, stored peas. The eggs are laid in the growing pods of the plant, and only one generation develops each year. The beetles remain in the pea until the time of planting, if stored at ordinary temperatures of winter, but if the seeds are kept where it is warm, many emerge and die before spring.

Control: Storing the seed in a warm place during winter will tend to cause the beetles to emerge and die. Fumigation with carbon bisulphide at the time of shelling (No. 37 a) is the surest means of destroying these pests.

II. *Sucking Insects.*

Aphids. (See under BEAN).

III. *Diseases of Pea.*

Powdery Mildew. (See under BEAN).

POTATO.

I. *Chewing Insects.*

Blister-Beetles. (See under BEET).

Colorado Potato-Beetle. This insect, called commonly the "Potato Bug" or Striped Potato Beetle, passes the winter in the pupal and adult stages and appears in the spring, feeding upon the young potato plants as they are issuing from the ground. Their bright yellow eggs are laid in clusters on the under side of the leaves, and from these hatch, in a short time, livid, reddish, grub-like larvæ which feed greedily upon the plants. They mature about mid-summer and a second brood of larvæ follows shortly thereafter, which usually result in a fall brood of beetles hibernating over winter.

Control: Paris green is the poison now most used in destroying potato bugs. It can be applied either as a spray (No. 26 a) (the addition of one pound of fresh lime, slacked, to the above will neutralize the free acid in the "green" and prevent burning the foliage), or in the dry state either pure by means of "blow guns" or better mixed thoroughly at the rate of about one pound to fifty of some inert material such as air-slaked lime, wood ashes, dry road dust, (No. 26 b), etc. In the dry form it will adhere to the foliage best when applied while the plants are wet with dew. Arsenate of lead (No. 27 b) or (No. 27 c) is also rapidly effective in destroying potato beetles.

It is important that the second brood of larvæ be destroyed, as well as the first, since the insects maturing from this brood pass the winter and thus insure infestation of the following year's crop.

Flea-Beetle. (See under CUCUMBER).

Potato Stalk-borer. An insect which is responsible for great and apparently increasing damage to the potato growing industry of this State is the Potato Stalk-borer.

The adult is a small ashen-gray weevil about one-sixth of an inch in length. It has a black snout and is marked with three black spots at the base of the wing covers. The eggs are laid in the stems and larger branches of the potato vines and some allied plants, as Jimson-weed and horse-nettle. From these eggs hatch white larvæ

which feed upon the interior of the stalks, causing them to wilt and die. Pupation takes place inside the stalks about the time the potato crop is harvested, and the beetles mature shortly afterward. They spend the winter in the adult stage inside the vines.

Control: Gathering and burning the infested vines in the fall just after the crop is harvested is the simplest and most effective method of controlling the stalk borer. Destroy weeds also which they are known to infest.

II. *Sucking Insects.*

Aphids. (See under *BEAN*.)

III. *Diseases of Potato.*

Blackleg. This is the common name by which a recently introduced bacterial disease is known. It affects the lower part of the stem and the tubers of the potato. The stalks show the first signs of the disease when they are six or eight inches high and have made vigorous growth during moist weather. Affected plants grow unnaturally upright, are plainly unthrifty, light green in color and undersize. The lower part of the stem turns black at or beneath the surface of the ground. This blackened area becomes soft and rots, as do the tubers when the disease has invaded them.

Control: Do not plant seed from infected fields nor in infected soil. No potatoes but those free from even the least appearance of injury should be planted. Reject all seed which has wounds, cracks, and decayed areas. It is believed the germs of this disease remain in the soil for some time. If seed, the source of which is unknown to the planter, be treated with a solution of formalin (45 a) as recommended for *Scab*, there may be no danger of introducing this serious malady into our fields.

Dry Rot. This disease first causes a decay of the stems and main roots, thus producing a wilt of the stalks and often causing them to fall over on the ground. The tubers are also affected and show a black ring just beneath the surface when cut. Such potatoes when stored develop a dry rot.

Control: Since the fungus lives for a considerable time in the soil, crop rotation is essential whenever dry rot becomes of serious importance. The use of pure seed is necessary to the control of the disease. All diseased potatoes should be destroyed by burning. Seed which may have come in contact with disease germs should be treated by dipping into a solution of formalin (45 a) as recommended for *Scab*.

Early Blight. The early blight of potato is a leaf disease causing circular or elliptical brown spots marked with concentric rings. They may occur on any part of the leaf but usually appear on the

edges of injury to the tissues. Leaf-beetles, therefore, as well as the potato-beetles superinduce an attack of the early blight by producing places for entrance of the fungus. It flourishes most vigorously during moist weather and may destroy entire leaves. The injury to the plant thus resulting is serious; the vines dry up and growth of tubers is checked. This disease must not be mistaken for tip burn of the leaves,—a condition caused entirely by the absence of sufficient moisture in the ground to maintain the growth of the plants.

Control: Spraying with Bordeaux mixture every ten days or two weeks, beginning when the plants are six or eight inches high, has been found to reduce to a small minimum the injury done by the early blight of potatoes.

Late Blight. The disease known as Late Blight of the potato, is more or less widely distributed over the northeastern part of the United States. It is very destructive only when climatic conditions are favorable to the growth of the fungus producing the injury. Warm, moist, murky weather is most favorable for its development. It does not appear before the last days of July, and is most abundant during August. A few hot and wet days at this season often suffice to give it a start, and then it spreads quite rapidly over large areas. Hot dry weather checks its spread.

The spots on the leaves affected with late blight are dark brown in wet weather, and present a water soaked appearance. When dry they are of a lighter color, but at no time do they have the rings so characteristic of early blight. Generally there is no stem injury, but sometimes the trouble extends to the stem. The fungus develops a dry rot upon the tubers, and this injury to the tissues exposes them to other rots both in the field and in storage.

Control: It is well known that some varieties are far more resistant to blight than are others, and in regions where the infection is known to be present such comparatively immune or resistant sorts should be grown.

Some of the common varieties of potatoes grown in this State which have shown the greatest resistance to late blight are Apollo, Eureka, Irish Cobbler, Quick Lunch, American Wonder, Early Rose, and Rural New Yorker No. 2. The disease can be prevented by spraying the plants with 5-5-50 Bordeaux mixture (26 b) beginning when they are about six inches high, and repeating the treatment every ten days or two weeks until three thorough applications have been made. Since the disease is carried over winter in the potatoes no seed from infected crops should be planted.

Scab. Potato Scab is a widely distributed disease, and affects not only the potato but beets and turnips. It produces on the surface of the roots or tubers a rough, corky, discolored, scaly spot or

pit familiar to growers and consumers alike, but too commonly called "worm holes." The fungus gains entrance through the lenticels and when once established spreads over a considerable area. These areas are more or less sunken when the tuber is attacked early in its period of growth, while those infected later are marked with crusts, pits or scabby areas.

The disease may spread from infected specimens in the bin to healthy tubers.

Control: Plant only clean seed, free from diseases and blemishes. Rotate crops. Treat seed, not known to be absolutely free from disease spores by immersing it for two hours in a solution of formalin (No. 45 a), or seed may be treated in the following manner:

"Dump the sack of potatoes onto the barn floor, and if the floor is tight so much the better, and spray them with this formalin mixture, so that they are all wet; if necessary turn them over. Now empty another sack of potatoes on the pile and wet these, and continue this until you have a full pile of probably 25 or 50 bushels. Cover them with a canvas or blanket and allow them to remain for four or five hours; not much more. Then spread them and get them dry as quickly as possible."

A solution of corrosive sublimate one ounce in eight gallons of water is also effective.

Seed to be dipped should be put into sacks of loose-meshed material in order that they may be immersed into the vessels containing the liquid and removed with facility. After treating they should be planted immediately or spread upon a clean floor and dried.

Corrosive sublimate is a deadly poison and potatoes dipped in this material must not be eaten nor fed to stock.

RADISH.

I. Sucking Insects.

Aphids. (See under *BEAN*.)

Root-Maggot. (See under *CABBAGE*.) (See Plate No. 23.)

II. Diseases of Radish.

Club Root. (See under *CABBAGE*.)

Downey Mildew. (See under *CABBAGE*.)

RYE.

I. Diseases of Rye.

Ergot. Rye, together with a few other common grasses, is subject to infection by the ergot,—producing fungus on the ear or "head." It is never a serious pest on account of its effect upon the host plant, but when the infected portion of the plant is eaten by cattle at a certain stage of its development, a disease known as ergotism is produced.

The presence of ergot in rye may be noted by the formation of a conspicuous curved black horn or spur which replaces the grain in the head.

Control: Proper precaution in the selection of seed, together with thorough preparation of the land, will prevent the danger of infection of rye with ergot.

SQUASH.

(The pests of *squash* are much the same as those of *cucumber and pumpkin, melon*, which see.)

STRAWBERRY.

I. *Chewing Insects.*

Leaf-Roller. The strawberry leaf-roller is a small, brownish caterpillar with a shining, yellow head, that folds the leaves of the strawberry plant by binding together the edges with its silken web. Inside of this protected nest it feeds upon the substance of the leaf, which turns brown as though scorched.

The adult is a reddish-brown moth expanding about one-half inch. The eggs for the first brood are laid upon the plants in the spring. The larvæ attain full growth in June, when they are about one-half inch long. They pupate within the rolled leaf and the adult emerges about mid-summer. There is a second brood of caterpillars which pass the winter in the pupal stage.

Control: Mow the strawberry patch as soon as the crop is harvested, and when dry burn it over. This will destroy the leaf-roller and some other insects and also the spores of fungous diseases. The insects of the second brood can be destroyed by the application of arsenates, as recommended for other chewing insects.

Strawberry Crown-Borer. This insect is responsible for considerable damage in some sections of this State, old strawberry fields being particularly liable to injury. It is a small, whitish, footless larva, about one-fifth of an inch long, and lives in the crown of the strawberry-plant, feeding upon the tissues. It hollows out the crown in a manner that nothing remains of the plant but a hollow shell to which the roots are attached.

The adult is a dark colored Snout Beetle, about half an inch in length. The eggs are deposited on the crown in the spring. The mature adults appear from August to October, when they feed upon the strawberry plants. They pass the winter as adults.

Control: If strawberry beds are fruited only once or twice this pest is rarely troublesome. Infested fields should be plowed under late in June or early in July. Any plants used for the new planta-

tion should be removed early to avoid transplanting eggs upon them. Spraying with arsenicals, such as arsenate of lead (No. 27 a) at the same time the adults are feeding upon the plants, will kill many of them. Burning over of the fields after picking is also beneficial.

Strawberry-Weevil. This small, black Snout-Beetle deposits eggs in the buds of strawberries, raspberries and blackberries, and then gnaws into the stem a short distance below, causing the buds to droop and wilt. From the eggs hatch little grubs which feed and develop in the bud, becoming full grown in a few weeks. They pupate in the bud. The adult beetles emerge about five weeks after the eggs are laid and migrate to other flowers, which they infest.

Control: Practice clean cultivation. Plant chiefly pistillate varieties for the crop. Plant early staminate varieties as decoys, and destroy these when infested. A perfect preventive consists in covering the strawberry beds with mosquito netting.

White Grub or Grub Worm. (See under CABBAGE.)

II. Sucking Insects.

Root-Aphids. Certain species of aphids live upon the roots of a variety of garden vegetables. The primary injury is done to the plants by the irritation and loss of sap incident to their method of feeding upon the roots. They are also accompanied by ants which tunnel around the roots, thus detaching them from the ground.

Control: Select clean plants and avoid planting on ground cropped with melons or cucumbers the previous season. Infested plants may be saved by applying tobacco either in the form of leaves, dust or stems spread liberally about the roots or tobacco decoction made by steeping tobacco in water (41 a). Dip roots of infested plants into tobacco decoction before planting.

III. Diseases of Strawberry.

Leaf Spot. The commonest disease of the strawberry is the leaf spot, sometimes also called "leaf blight." Its characteristic appearance is the small discolored spots which develop about the time of blossoming. These spots are at first reddish or purplish, and as they spread and coalesce the centres turn whitish. There is a difference in the susceptibility of varieties although all kinds are more or less subject to injury from this disease. Among the most resistant varieties are such as Brandywine and Marshall.

Control: Plant only healthy plants. Spray the plants with Bordeaux mixture (42 a) before time of blossoming. Mow and burn over diseased patches soon after harvesting the crop.

SWEET POTATO.

I. *Chewing Insects.*

Flea-Beetle: (See under CUCUMBER.)

Tortoise-Beetles. Several species of leaf-eating insects are commonly known by this name because of their resemblance, in shape, to a tortoise. Some are also called "Gold Bugs," since they are of a beautiful metallic yellow color. They often injure sweet potato plants by devouring the foliage both in the forcing beds and after the plants are set out. The damage to young plants is often serious when they are attacked before they get a start.

The insects pass the winter in the mature beetle stage in crevices, under bark, and in similar dry places where they can find shelter. They appear first in May and feed upon the foliage, eating roundish holes in the leaves. The eggs are laid singly on the leaf stems, or on the under sides of the leaves, and covered with a small mass of black excrement. The larvæ appear in a week and feed upon the foliage. They are flattened, oval creatures with processes or spines at the sides. By the middle of July they are full grown and pupate. The new brood appears in August.

Control: Young plants can be protected at the time of transplanting by dipping them into a mixture of arsenate of lead paste, one pound to eight or ten gallons of water. This will kill off the adult beetles as soon as they begin to feed. If the plants are attacked in the forcing beds, or later, in the field they should be sprayed with arsenate of lead mixture using from two to three pounds of the paste or one-half this quantity of the dry powder to each fifty gallons of water.

II. *Diseases of Sweet Potato.*

Black Rot. This disease may appear in the forcing bed upon the roots of the seedlings, either as a result of using infested seed or planting in soil containing the fungi. Such plants appear black on the shank or lower part of the stem and roots. Upon the full grown roots the disease appears in the form of dark patches or decayed spots of various sizes which are of a green color beneath the skin.

Control: Avoid planting infected seed. Examine seedlings before transplanting and reject all showing discolorations on the shank or roots. Rotate crops. Avoid the accumulation of water in the forcing beds.

TOBACCO.

I. *Chewing Insects.*

Cut-worms. (See under CABBAGE.)

Flea-Beetle. (See under CUCUMBER).

Grasshoppers. (See under OATS).

Horn-Worms. These are the ordinary green tobacco worms and are common in all sections of the State where tobacco is grown. They feed also upon the tomato and are thus sometimes known as the "Tomato Worm." There are two common species with similar life history and habits.

The "Tobacco Worm" is green in color, with oblique bands of white on the sides of its body, and supplied with a stout horn on the posterior end. When full grown it measures from three to four inches in length.

The eggs are small greenish-white bodies, placed singly, generally on the under side of the leaves. The young hatch in three or four days and begin to feed upon the leaves, confining themselves to the more tender parts, but later in their development devour the entire leaves, with the exception of the mid-rib.

The pupæ are brown, cylindrical objects, and may be known by the handle-like process at one end, which contains the tongue of the insect. These pass the winter a few inches beneath the surface of the ground.

The adult insects are Sphinx Moths with stout, narrow wings and long, slender tongues. They are of a dull grayish color, flying swiftly in evenings and by night, when they feed on the nectar of the long-tubed flowers, such as the Jimson weed and Four O'clock.

Control: The common method of destroying tobacco worms has been that of hand-picking. This is probably as good as any where there are but a few worms found infesting the plants. In case of general infestation, however, there is no more economical means of killing the "worms" than by spraying with an arsenical poison, such as arsenate of lead (No. 27 a) or Paris green (No. 26 a). The spray should be applied when the worms are quite small and before they have a chance to do much damage. A knapsack sprayer is a convenient type to use for spraying tobacco, in the field. The poison can also be applied in the dry form.

The adult moths can be poisoned at the time they visit the flowers of the Jimson weed by poisoning with strychnine.

Tobacco worms are subject to the attacks of several important natural enemies which tend to hold this pest in check. The principal enemy is without doubt a small, four-winged insect which lives in

the larval stage inside the body of the worm. This fly lays its eggs upon the outside of the tobacco worm. The larvæ hatching from these eggs burrow into the worm and feed upon its tissues. They pupate upon the outside in small, white, egg-like cocoons upon its back and sides. Worms thus parasitized show evident signs of weakness and will not mature. They should not be destroyed, thus giving the parasites a chance to complete their development.

Tobacco worms are also affected by a bacterial disease which causes them to turn black, shrivel up and die.

The Tobacco Seed Pod Worm. This is a new name for an insect, but not a new insect, as it is really an old insect with modified habits. Tobacco growers in Lancaster County have noticed the seed pods of their seed tobacco eaten open and destroyed. By careful examination and keeping specimens in cages for sometime we learned that this is done by the larvæ of a moth. In fact in its destructive stage it somewhat resembles a climbing cut-worm. The winged moth lays the egg on the seed pod and the larva hatches and gnaws through to the inside where it feeds voraciously.

Control: One remedy for this pest would be to spray the young pods of the seed tobacco shortly after the blossoms drop with an ounce of arsenate of lead in each gallon of water. The larva goes to the ground to pupate after it is done feeding and passes the winter in the soil coming forth the next summer as the mature moth. Therefore, fall plowing and late fall and early spring cultivation of the soil will help to break up the cells where the chrysalis is found and consequently it is destroyed.

Cigarette Beetle. This insect, less than a quarter of an inch in length, is very fond of tobacco in all forms, from dried leaf to manufactured products. The larvæ make tunnels in the tobacco and ruins it for trade.

Control: Infested tobacco should be fumigated with hydrocyanic acid gas (38).

II. *Sucking Insects.*

Stinking Squash-Bug. (See under CUCUMBER).

III. *Diseases of Tobacco.*

Damping off. (See under CELERY).

Root Rot. A fungous disease causing injury to the roots affects tobacco as well as other species of plants such as the violet, ginseng, peas and lupines. Roots affected by fungous Root Rot do not always develop a normal root system. On pulling them up everything but a stub may be broken off. It is most injurious in the seed bed. Affected plants may not be killed, but a cluster of new roots may be formed above the point of injury. Others will be stunted permanently.

Control: If the seed bed has become infected the soil should be sterilized. Diseased plants should be discarded. Thorough aeration and drainage of soil in the beds is desirable.

TOMATO.

I. *Chewing Insects.*

Cut-worms. (See under *CORN*).

Flea-Beetle. (See under *CUCUMBER*).

Horn-Worms. (See under *TOBACCO*).

II. *Sucking Insects.*

White-fly. This is a serious pest of tomatoes and other plants especially in greenhouses. They are very small, winged insects having an expanse of about one-eighth of an inch. They are covered with whitish powder and feed by sucking the sap from the under side of the leaves.

Control: Spray the under sides of the leaves with a solution of laundry soap one pound in six or eight gallons of water or with Kerosene Emulsion containing five per cent. of oil. They can be destroyed readily in greenhouses by fumigating with hydrocyanic acid gas using one ounce of Potassium Cyanide, two ounces of Sulphuric Acid to four ounces of water for every four hundred cubic feet of space.

III. *Diseases of Tomato.*

Damping-off. (See under *CELERY*.)

Leaf Spot. The disease known as leaf spot or "Blight" appears first in numerous, minute, oval spots upon the leaves. The affected leaves turn yellow and drop one after the other until the plant presents a very ragged appearance. The stems as well as the leaves become affected. Any fruits which may have formed drop off prematurely.

Control: Spray with Bordeaux mixture (No. 42 a). The first application should be made soon after transplanting and repeated every ten days or two weeks until fruits are beginning to ripen. Gather and burn all parts of plants left on the patch after the crop has been harvested.

Anthrachnose. This is one of the leading fruit diseases of the tomato. It is due to a fungus which causes sunken discolored spots which later become the seat of rot. Under moist conditions it spreads rapidly, producing a general decay of the fruits.

Control: Spray with Bordeaux mixture (No. 42 a). Remove and destroy affected fruits as soon as detected. Destroy remnants of plants in the fall after harvesting the crop.

Tomato Rot. The primary cause of this condition is not a fungus. There are certain varieties of tomatoes which, especially during wet seasons, burst the rind at the blossom end which supplies an entrance for the germs of rot. This decay spreads and finally involves the entire fruit. It is more prevalent on rough skinned varieties with an imperfect blossom end.

Control: Select smooth, resistant varieties and support stalks on trellises.

TIMOTHY.

I. Chewing Insects.

White Grub. (See under *CORN*).

II. Sucking Insects.

Thrips. (See under *OATS*).

III. Plant Diseases of Timothy

Ergot. See under *RYE*).

WHEAT.

I. Chewing Insects.

Wheat-head Army-Worm. This is a light colored larva, striped with yellow, about an inch in length, feeding upon the seeds of wheat, rye and other grasses, making it appearance in destructive numbers about the time the grain is ripening. The adult moth is of a pale gray color, with a silver-gray margin to the outer edge of the fore wing.

Control: If the grain is sufficiently ripe, harvest and thus prevent further injury. Spray infested plants with kerosene emulsion (No. 32 a). Protect toads, lizards, frogs, turtles and birds, which feed upon these insects.

Wheat Midge. This insect very much resembles the Hessian fly in shape and size. The eggs are deposited in the crevices between the chaff in the wheat heads, a few weeks before harvest time. From these hatch minute white maggots which burrow into the kernels. They become full grown in three or four weeks, and pupate in the ground where they spend the winter.

Control: Practice fall plowing thus destroying the pupæ in the ground.

II. *Sucking Insects.*

Hessian Fly. This is the most destructive insect pest of wheat in this State, the crop of 1911 having been damaged to the extent of millions of dollars. So severe was the injury to the wheat fields of certain sections that the crop harvested was less than one-fourth of a normal yield. The Hessian Fly is always present with us in greater or smaller numbers, but in average years the damage they do is so small as not to be noticeable. Ordinarily this fly is held in check by other insects which prey upon it. Unfortunately they cannot be relied upon to protect the wheat crop at all times by preventing periodical outbreaks during which the crop is almost entirely ruined.

The appearance of the mature crop injured by the Hessian fly is well known. The stalks bend over at the base of the stem and fall upon the ground. A seriously infested field before harvest time presents, therefore, a characteristically tangled condition.

There are two broods each year. The eggs of the first or fall brood are deposited on the leaves of the little wheat plants as many as twenty-five on a single leaf. The eggs are very small oval bodies and reddish in color. They hatch in four or five days producing tiny, white maggots which crawl down the leaf and leaf-sheath to the foot of the stems and lodge at the joint near the ground. Here they remain sucking the sap and develop to a length of one-eighth of an inch. About the time cold weather sets in they pupate in little brown cases resembling very much a flax seed. In this condition they pass the winter. The flies emerge in the spring and lay the eggs for the second brood on the growing wheat stalks usually a little higher up than the lower joint.

The adult fly is about the size of an ordinary sized mosquito although somewhat stouter in body.

Wheat is the favorite food plant of the Hessian fly although it also attacks rye barley.

Control: There are several known methods by means of which damage by the Hessian fly can be greatly reduced, although co-operation among farmers in each community is necessary, in order to absolutely control this pest in successive seasons. Burning the stubble soon after reaping the crop is valuable. It destroys the flax seed pupæ in the stalks remaining on the field.

Plowing under the stubble soon after harvesting the crop will serve the same end where burning is impracticable, but the ground should be turned entirely over so as to bury all parts of the stubble.

Sow trap crops early. These may consist of a narrow strip of wheat extending through or around the patch to be sown to wheat in the fall. The flies will deposit their eggs upon these plants which can be plowed under after danger from further egg laying is past.

The most successful method of controlling this pest is, without doubt, late fall planting. The flies appear and deposit their eggs during August and the first part of September after which they die. Consequently if the crop is planted after the period of egg laying is past, say about September 20th in southern Pennsylvania and ten days earlier in central and northern Pennsylvania there is no danger of infestation by this brood nor by a subsequent brood as there will be none wintering over. It is, however, necessary that this late planting be practiced by all farmers else the flies which may winter over in the fields sown early will be enough to infest the entire neighborhood in the spring without regard to time of planting. Co-operation is therefore necessary among all farmers in an infested locality.

Volunteer wheat should be destroyed so as to prevent the flies from breeding there.

"Green Fly" or Aphis. During certain seasons wheat, oats and certain grasses suffer injury from these greenish and brownish plant lice. They reproduce by bringing forth living young and increase, in favorable seasons, with frightful rapidity.

Control: Preserve insect-eating birds. General spraying seems impracticable, but circumscribed, infested areas should be sprayed as for Apple Aphis.

III. Diseases of Wheat.

Ergot. (See under *RYE*).

Rust. (See under *OATS*).

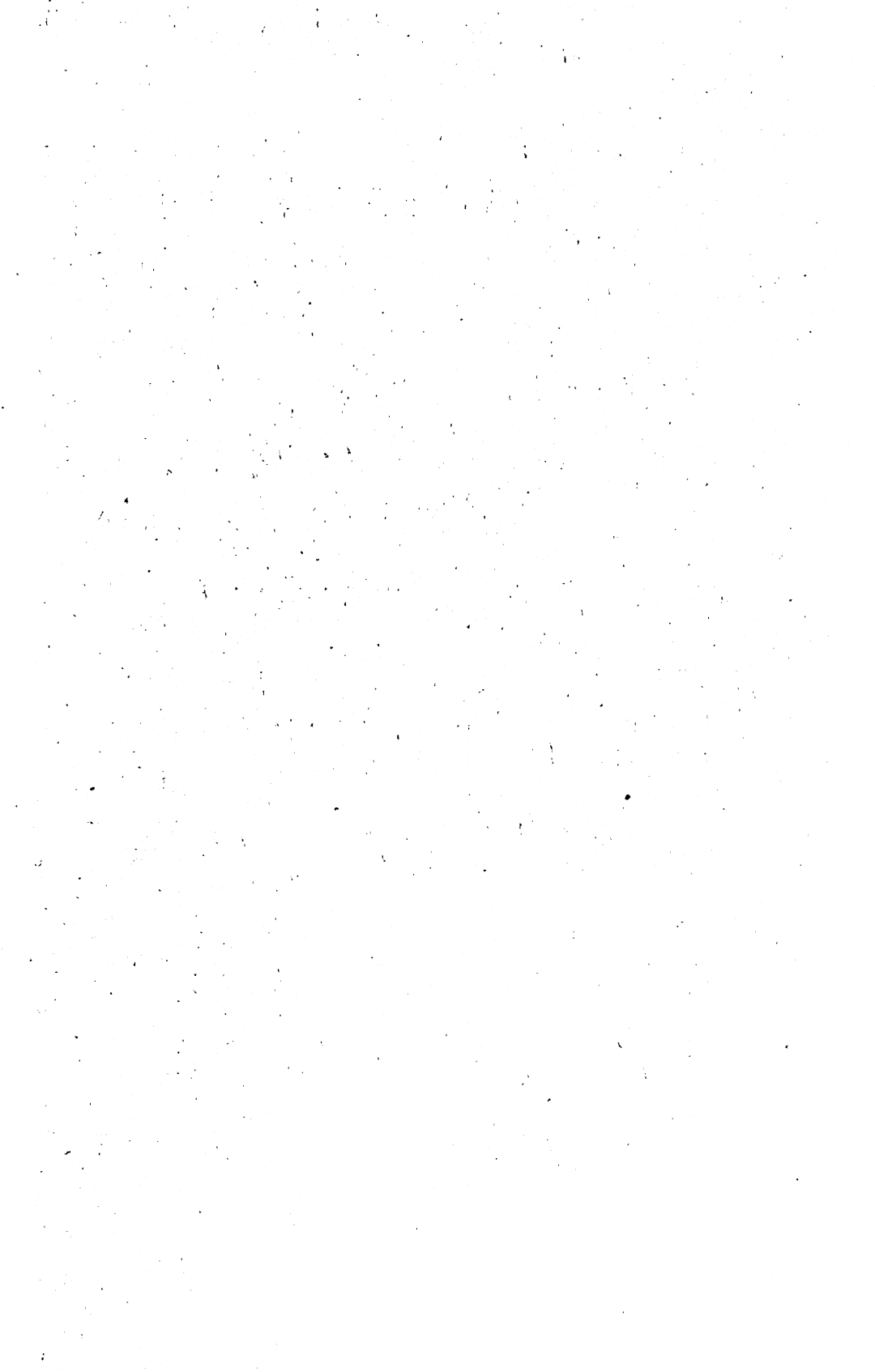
Loose Smut. (See under *OATS*).

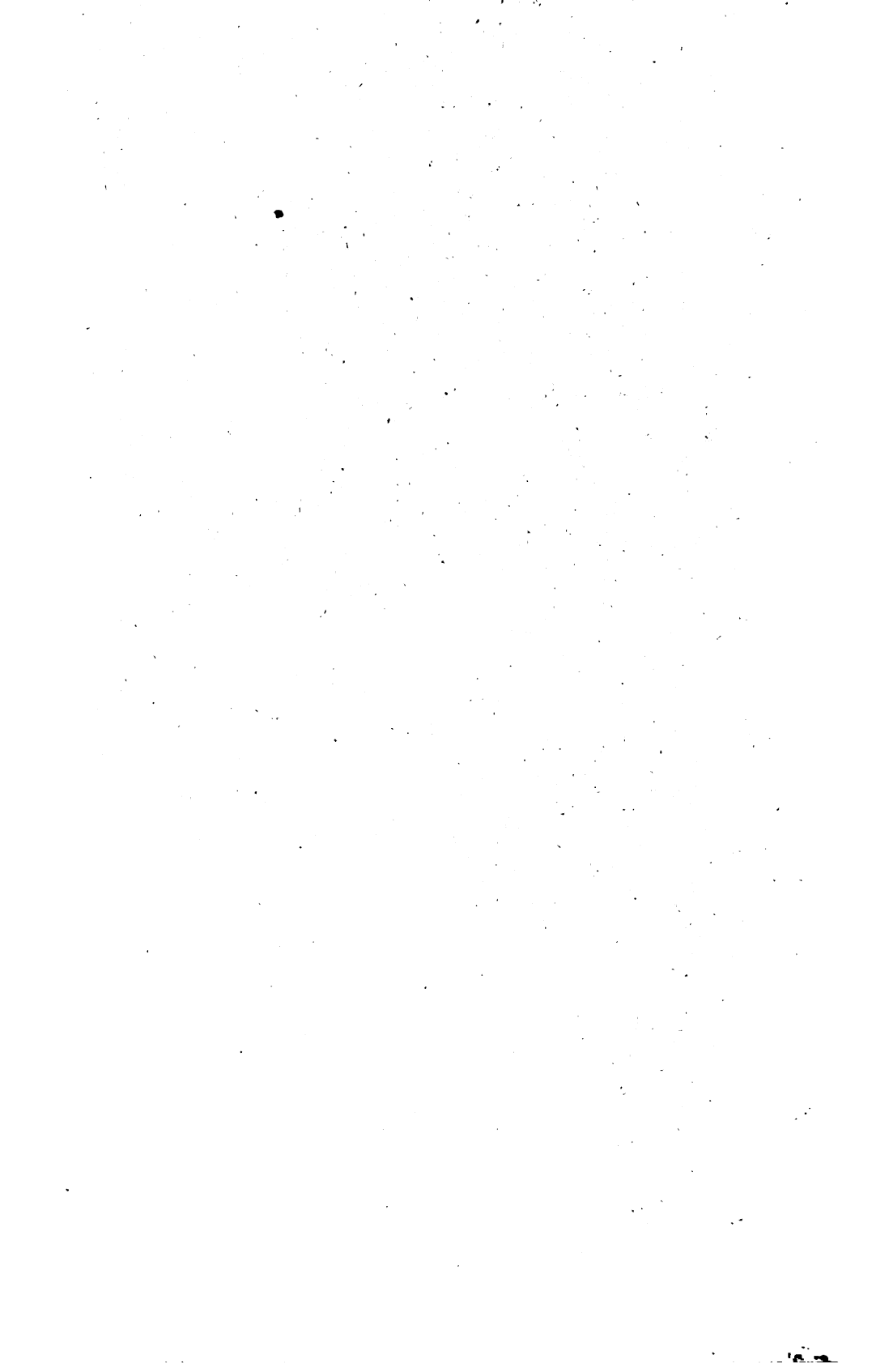
Stinking Smut. This is a fungous disease of wheat and is not known to attack any other grain. It is widely distributed over most of the wheat growing sections of the United States and Canada. The fungus affects all varieties of wheat and has been known to destroy as much as two-thirds of the entire crop. It winters over in the soil and this is the reason that wheat grown for several years in succession in the same fields is most commonly affected in certain regions.

The spores are produced in the ovule sacks so that the kernels are the chief seat of the spores at the time the masses mature. These spore-masses produce a very disagreeable odor, especially when the grain is stored or milled.

Control: Treat infected grain with formalin solution as recommended for *oat smut*, rotate crops, and avoid putting smutted straw on ground to be seeded to wheat. See that all smutted straw is well rotted in the compost heap before hauling it to the field for manure.







THE BI-MONTHLY ZOOLOGICAL BULLETIN

OF THE

DIVISION OF ZOOLOGY



OF THE

PENNSYLVANIA DEPARTMENT OF AGRICULTURE

VOL. II.—No. 6

SUBJECTS: { PESTS OF TREES.
INDEX TO VOLUME II.

NOVEMBER 1912.

H. A. SURFACE, D. Sci., Economic Zoologist,
Editor

*Entered as Second-Class Matter, January 13, 1911, at the Post Office at Harrisburg, Pa.,
under the Act of June 6, 1910.*

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VOL. II, No. 6.

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A later bulletin will treat the subject of pests of small fruits and grapes, household plants, lawns, flowers, households and buildings, live stock, poultry and mankind.
 H. A. S.

INTRODUCTION.

We take pleasure in presenting to the public this issue of the Bi-Monthly Bulletin of the Division of Zoology on the subject of Pests of Trees. This is a companion bulletin to the July and September numbers. The formula cited in this are published in full in the July number, and the numbers herein given refer to the respective numbers of formulae there published.

The September bulletin treats the subject of pests of Field and Truck Crops and also refers to the formulae published in the July number. We propose to publish one more bulletin to complete this particular series. This will discuss the subjects of Pests of Small Fruits, and Truck Crops, Household Plants, Lawns, Flowers, Households and Buildings, Live Stock, Poultry, and Mankind. These four bulletins will comprise a series on the pests afflicting mankind and attacking his property, which is more complete than any that has before been published in this State. They should be kept for future reference, as we do not propose to publish again on these topics within two years.

It will be noted that in these bulletins the pests are classified into groups as follows: Sucking Insects, Chewing Insects, Other Pests, Plant Diseases. This is because the remedies for those belonging to any one group are similar, while for those in different groups they are generally not at all alike.

Persons desiring to send specimens for identification and inquiries are directed to see that all specimens are so packed that they will be protected in the mails, as in small tin, or wooden boxes. The name and address of the sender should be on or in each package. Letters should give full descriptions of conditions. Replies from this office will be prompt.

Address: H. A. SURFACE, Economic Zoologist,
Harrisburg, Pa.

N. B. The address of the Economic Zoologist is not State College.

APPLE.

I. *Chewing Insects.*

The Apple Bucculatrix: (*Bucculatrix pomifoliella* Clem.) The adult insect is a light brown moth about one-tenth of an inch in length. They appear during the latter part of May and the caterpillars are found about a month later feeding on the leaves. These larvæ tunnel in the leaves for about the first eight days of their existence, when they come to the exterior there to feed on the leaves by beginning at the edge. These caterpillars

are first yellowish in color, but become greenish-brown with the molt. A second brood appears, whose members pass the winter as pupæ in narrow, but long, white ribbed cocoons attached to the twigs.

Treatment: These hibernating pupæ can be killed by spraying with lime-sulphur solution (34), or whale-oil soap solution (33 b), or kerosene emulsion (32 a or 32 b), when the trees are dormant. The tiny caterpillars can be controlled by sprays of lead arsenate (27 a), or Paris green (26 a, using 5 oz. instead of 8 oz.); this should be applied when the caterpillars are actively feeding.

The Apple-leaf Crumpler, or Case-bearer: (*Mineola indiginella* Zell.) During June or July a small gray moth deposits its eggs on the leaves of the apple and quince. The brown larvæ live, when not eating, in silken cases, which they construct and to which many partially eaten leaves are attached from time to time. The caterpillars pass the winter in these cases, which hang from the twigs by threads. Feeding is resumed in spring with the re-appearance of leaves. About June the larvæ are transformed into pupæ and the moths emerge in about two weeks.

Treatment: Larval cases should be gathered and buried in winter. The caterpillars, however, are controlled by the regular spraying for the codling moth. Spray with lead arsenate (27 a), or Paris green (26 a, 5 oz. instead of 8 oz.) just before the buds burst.

The Apple-leaf Skeletonizer: (*Hulstia hammondi* Riley.) This is the larvæ of a small purplish moth, which has two light bands on the front wings. The caterpillars appear late in summer and feed upon the parenchyma, or soft part of the leaf. They spin a silken covering over the upper surface of the leaf. When full grown, the larvæ are pale green to brown in color and about one-half inch in length. Cocoons are formed on the leaves and the adult moths issue in about two weeks. The second brood passes the winter in the pupal stage.

Treatment: As with the preceeding.

The Apple-leaf Miner: (*Tischeria malifoliella* Clem.) This is the larvæ of a small moth. The caterpillars, immediately after hatching, bore into the leaf and feed upon the soft tissue, thus forming a winding tunnel, which gradually enlarges as the larvæ grow. The adult form is reached in about six weeks and several broods appear in a season.

Treatment: Spraying the trees seems to be of little profit. Destruction of the fallen leaves by burning is advisable as the larvæ pass the winter in them.

The Apple-leaf Roller: (*Archips rosaceana* Harr.) This is a greenish-yellow caterpillar, about one-half inch long. The adult is a small orange-colored moth. The eggs are laid on the unfolding

leaves. Later the larvæ roll the leaves into a tube and feed within. Here, too, the pupate. Several broods are produced in a season.

Treatment: Same as for "Apple-leaf Folder."

Bagworms: (*Thyridopteryx ephemeraeformis* Steph.) There are a number of species of moths having larval forms, which produce bag-like cases on a variety of trees. A common form is that which occurs on apple trees. The larvæ live within the "bag," which is covered with bits of sticks and leaves, and which is carried about by them. When ready to pupate, the larva attaches the "bag" to a twig. Thus, the female moth remains during winter and dies in the spring, leaving the bag filled with eggs. The male, however, emerges in the latter part of the summer.

Treatment: While the insects are feeding, spray with lead arsenate (27 a), or Paris green (26 a). Pick off and destroy the "bags" in winter, or whenever seen.

The Bud-moth: (*Spilonota ocellana* Schiff.) The larvæ of this insect are small brown caterpillars with black heads. They feed upon the young and developing buds and leaves, binding them together with webs.

Treatment: Spray with lead arsenate (27 a), or Paris green (26 a) immediately before and after the buds open.

The Buffalo Tree-hopper: (*Ceresa bubalus* Fab.) This tree-hopper is green in color and about one-third of an inch in length. It is of a peculiar appearance, being broad across the thorax or chest, and tapering decidedly to the posterior end. The insect derives its name from a fancied resemblance to the buffalo. The adult deposits its eggs in crescent-shaped incisions in the bark, causing some injury to young shoots; these incisions are in pairs and the "horns" of one incision touch those of the other. The eggs are deposited in the late summer or early autumn and remain dormant until the following spring.

Treatment: Spray with contact insecticides, such as lime sulphur solution (1-½ gal. concentrated to 50 gal. water), whale-oil soap solution (33 b), or kerosene emulsion (32 c), when the pests are sufficiently troublesome. Cut out the rows of eggs, or remove the infested twigs when seen during the dormant period of the tree.

The Cow Tree-hopper: (*Ceresa taurina* Fitch.) Similar to the preceding in habits, and controlled by the same measures.

Canker-worms: (*Paleacrita vernata* Peck.) These are variously known as "loopers," "span-worms," and "measuring worms." They are very destructive, as they feed on foliage in the early spring. The eggs from which they come, are hatched about the time the buds burst, when the larvæ feed upon the foliage for about four weeks, and are then full grown. At this time they descend to the ground to

pupate. The adult male moths have wide spreading wings, while the females are wingless. They pass the winter in the soil and climb the trees in the very early spring to lay their eggs on the twigs. The Fall Canker Worm and Spring Canker Worm, are both found within this State.

Treatment: Apply an impassible barrier, such as a roll of cotton, or wool, or a sticky band, to the trunks of the trees very early in spring. As soon as the caterpillars appear, spray with lead arsenate (27 a), or Paris green (26 a). Destroy eggs seen on twigs when pruning.

The Apple-seed Chalcis: (*Syntomaspis druparum* Boh.) The adult of this pest is a small, green wasp about one-eighth of an inch in length. The eggs are deposited in the seeds of apples, when the fruit is one-half inch or more in diameter. On warm days in June the female alights upon the young apples and drives her long ovipositor through the flesh and into the seeds. The larvæ are grub-like and have brown heads. They feed upon the kernels until September, at which time they are full grown and have devoured the entire contents of the seed. They pass the winter inside the seed shells in the pupal state and emerge from the apples as mature flies early the following summer. Infested apples are much undersized and misshapen. The point at which the egg was introduced appears as a black dot occupying a depression on the surface of the fruit. From this puncture a brownish line of hardened tissue extends to the infested seed. This pest annually destroys tens of thousands of bushels of apples in the north-eastern part of Pennsylvania.

Treatment: Destroy all apples left under and on the trees in the fall. Pasture pigs under apple trees. This measure will prove effective if practiced generally and uniformly in infested locations.

The Codling Moth: (*Carpocapsa pomonella* Linn.) The adult is a small, brown moth, which deposits its eggs in spring on leaves and fruit of young apples. The larvæ eat their way to the core, around which they feed for several weeks. Then they bore to the exterior of the apple, crawl out, and pupate in crevices in the bark, or under rubbish. The adult appears in about two weeks (latter part of July), and produces a second brood.

Treatment: Spray with lead arsenate (27 a) immediately after the blossoms fall, in a coarse strong spray, so as to fill the calyx cups of the erect fruit. Apply a second spray a month after the first. In this second spray the lead arsenate should be mixed with Bordeaux mixture (42 a), or a dilute lime-sulphur solution, if fungous troubles are anticipated (one gallon and one quart of concentrated lime-sulphur solution, commercial or home-boiled, in forty-nine gallons of water and to this add two pounds of lead arsenate). If the first brood is not cleaned up, spray the last of July for the second brood.

Curculios: (*Anthonomus quadrigibbus* Say.) The adult beetles appear in early spring and feed upon the young foliage. When disturbed they feign death,—a characteristic of curculios. Soon after the young apple is formed, the insects feed upon it and deposit their eggs under the flap of a semi-lunar cut in the side of the fruit. From the egg hatches the larva, which develops within the little fallen apple. The injured apples, which do not drop, rarely contain living larvæ, but become quite knotty. This is the chief cause of knotty apples, pears, and quinces. They remain as the “worms” in the stone fruits.

Treatment: Spray with arsenate of lead (27 a) or Paris green (26 a), as soon as the petals fall, and repeat in ten days or two weeks. The practice of jarring the trees and collecting the curculios on a screen and destroying them is also recommended. Since the insects hibernate beneath the surface of the ground, turning the soil by plowing and very late fall and early spring cultivation will aid in destroying the insects by breaking the earthen cells in which they pass the winter as pupæ.

The Fall Web-worm: (*Hyphantria cunea* Dru.) These larvæ are especially common in the late summer or early autumn, when their presence is made known by the webs which they make. The adult is a white moth, which deposits its eggs on the leaves of a variety of trees. The larvæ live under a thin irregular loose web, which they construct over the leaves, and which they extend as the food supply becomes exhausted. The full grown caterpillars are about an inch in length and the body is densely covered with yellow hairs. Pupation takes place in the ground. From central Pennsylvania southward there are two broods per year, the first appearing in June.

Treatment: Remove affected branches and burn them. Spraying with lead arsenate (27 a), or Paris green (26 a), is effective if done thoroughly so as to force the poison through the web, and if done early, while the larvæ are yet quite young.

To insure good results it is advisable to expose the larvæ by brushing off their webs before spraying. In many instances it is possible to brush the caterpillars from the trees and crush them on the ground, or merely to strip them off by hand. Burning with a torch is not recommended for any pests, as it injures the trees.

Flat-headed and Round-headed Borers: (*Chrysobothris femorata* Fab., and *Saperda candida* Fabr.) These are the larvæ of beetles. They spend from one to three years burrowing beneath the bark, or through the wood near the ground and have a very devitalizing effect on the trees they infest, often killing them directly.

Treatment: Locate the borers by their saw-dust castings at any time they can be seen and with a spring-bottom oil can inject carbon bisulphide into the holes, closing them with clay. As preventive of

borers, paint the lower eighteen inches of trunks of trees with whale-oil soap solution (2 lbs. soap to 1 gallon of water), or pure white lead and raw linseed-oil, or spray the trunks with arsenate of lead and lime-sulphur solution (1 gal. conc. lime-sulphur to 7 gal. water), or lime (2 lb. lime, 1 gal. water), during June or July. Prune back the tree in proportion to injury.

Scolytid Bark-beetles: (principally *Scolytus rugulosus* Ratz.) These are very small, brown beetles, which burrow in declining or dying trees making diverging channels, in which the larvæ feed on fungous growths. The pupal stage is passed in the tree and the adults make their exit through the bark by making small holes. These holes give badly infested trees the appearance of having been punctured by small shot: hence, the common names—"Shot-hole Borers" and "Bark Beetles," which are given to these insects.

Treatment: Generally speaking, these beetles attack only declining trees. Cut and burn infested trees or parts of trees to destroy them. Stimulate the growth of the trees by cultivation, fertilization, mulching, watering.

The Snowy Tree-cricket: (*Æcanthus niveus* DeG.) These crickets are white in color, and live mostly on trees, brushes or even low plants, feeding on plant lice and other soft bodied insects. They sometimes cause serious damage to twigs by laying numerous long, curved, yellow eggs therein. Infested twigs may be known by the row of small punctures in them. Eggs are laid in the fall and the young hatch in the spring.

Treatment: Remove infested twigs and burn them during the winter. After hatching, the nymphs, as the young crickets are called, can be killed by spraying with dilute contact insecticides, such as lime-sulphur solution (1 gal. and 1 pint to 49 gal. water), whale-oil soap solution (33 b), or oil emulsion (32 c). Clean cultivation of the orchard and spraying for plant lice, etc., will reduce the Tree Crickets.

Tent Caterpillars: (*Malacosoma americana* Fabr.) These are distinguished from the Web-worms by the fact that, unlike the latter, they do not feed in the tent-like structure, but retire to it only at night, during wet weather, or when not feeding. They become full grown in about six weeks, and are then about two inches long. Pupa-tion takes place in the tent, or under boards and in other protected locations and the adult comes forth as a brown moth. The eggs are laid in the summer in bands or rings, around twigs and remain exposed all winter.

Treatment: Cut off and remove the egg masses before the foliage appears. Tear out webs, shoot the larvæ out with powder only, or spray with lead arsenate (27 a), or Paris green (26 a), at any time the caterpillars are present.

Twig Borers: (*Amphicerus bicaudatus* Say.) The adult insects bore in the twigs in spring entering at the bud. The larvæ live in the roots of cat-brier and in dead grape vines.

Treatment: Destroy the breeding places indicated.

The White-marked Tussock Moth: (*Hemerocampa leucostigma* S. & A.) The larvæ of this moth are the familiar yellow caterpillars, with vermillion-red head, four white tufts of hairs on the forepart of the back and a brush of long, brownish-black hairs at the posterior end of the body. The females, which are wingless, lay their eggs in white masses on old cocoons, on the trunks and larger branches of trees, so that these eggs masses are quite conspicuous.

Treatment: The white egg masses should be gathered and destroyed in late winter, or early spring, or should be killed by touching carefully with a sponge dipped in kerosene and lamp black, and held by a long pole. Otherwise, the caterpillars should be killed as soon as possible after they appear. Spray the foliage with lead arsenate (27 a), or Paris green (26 a).

The Apple Fruit-maggot, or Railroad Worm: (*Rhagoletis pomonella* Walsh.) The adult insect is a black fly, about one-fourth of an inch in length, which deposits its eggs under the skin of the apple. The maggot burrows in the flesh of the fruit, thus producing brown, winding tunnels. The infested apples fall to the ground, which the larvæ enter, and in spring the adult fly appears.

Treatment: Spraying is of no avail in eradicating this insect, as the adults do not feed upon the tree, and the maggot feeds entirely within the apple. Destroy all infested apples within half a week after they fall, or gather them and feed to stock. Let hogs or sheep eat early fallen fruit.

II. Sucking Insects.

The Apple Aphis or Plant Louse: (*Aphis mali* Fabr.) Early in spring there appear small green soft insects called aphids, which infest the leaves and twigs. Into these the aphids insert their tiny beak, inject a poison, and suck out the juices. This stunts and curls the leaves, arrests growth, and results in deformed and stunted fruit.

Treatment: All curled leaves must be removed before spraying is begun. Spray with lime-sulphur solution (1 gal. and 1 pt. in 49 gal. water) immediately before the buds burst.

This kills the eggs on the twigs where they wintered. Spray with kerosene emulsion (32 c), soap solution (33 b), or tobacco decoction, when pests first appear, but before the leaves curl. The nozzle should be so directed that the spray will strike the under side of leaves and be sure that the liquid comes into direct contact with all insects.

Leaf-hoppers: (*Empoasca mali* Le B.) These are small light green to white insects, about one-tenth of an inch in length. They live by sucking the juices of the leaves, attacking the more tender ones. They are frequently especially bad on nursery stock. The young run quickly, while the old both jump and fly.

Treatment: As for *Apple Aphis*. (See also "Leaf-hopper" of grape).

The Oyster Shell Scale: (*Lepidosaphis ulmi* Linn.) The waxy covering of this scale insect is gray or brown, and resembles an oyster-shell in shape. The milky white eggs are laid under this scale,—two broods being produced in a year. Badly infested trees have a rough and ridgy surface.

Treatment: Spray, while trees are dormant, with lime-sulphur solution (34); or when the insects hatch, and are still moving about, during the latter part of May, or in August, spray with soap solution (33 b), or kerosene emulsion (32 c), or with tobacco decoction (41 a), or hellebore (31 b).

Putnam's Scale: (*Aspidiotus ancylus* Putn.) This insect resembles the San José Scale, from which it may be distinguished by the absence of the depression around the tip, which is at one side of the center of the scale. It does not multiply as rapidly, and is not as poisonous nor destructive as the San José Scale.

Treatment: Same as San José Scale.

San José Scale: (*Aspidiotus perniciosus* Comst.) Bark badly infested with San José Scale, appears as though it had been dusted with ashes. This is due to a rough scaly covering, which can be rubbed off readily with the hand. The individual scales, in winter, are dark gray or black discs, about one sixteenth inch in diameter. About June first the young appear of a bright yellow color, moving about freely upon the bark. Soon they settle down and secrete a scale remaining fixed at this point forever. In fact, after they are once fixed they cannot be removed without killing them.

Treatment: Seriously infested trees should be pruned back when dormant in proportion to injury. For this pest, no spray has proved more efficient than boiled lime-sulphur solution, either home-boiled or commercial, which should be applied during the dormant season according to formula (34, dilute.)

The Scurfy Scale: (*Chionaspis furfurus* Fitch.) This insect resembles the oyster-shell scale very closely in habits and life history. The scale is white and that of the female is oval or fan-shaped, while the male looks like a narrow white line. The eggs and young are purple. They hatch about the third week of May, and again about the first of August.

Treatment: Same as for *Oyster Shell Scale*.

The Pear Psylla: (*Psylla pyricola* Forst.) This is a small, jumping insect, which resembles the seventeen-year "locust" quite closely in appearance, but is much smaller, being but about one-tenth of an inch long. It has four transparent wings and dark transverse stripes across its reddish abdomen. The eggs are deposited in the spring in the rough bark and on the buds. The young are nymphs, resembling the adults, but wingless. They insert their beaks into the tissue and suck out the sap.

Treatment: Spray with lime-sulphur (34) before the buds burst in the spring, as for San José Scale, or spray with kerosene emulsion (32 c), or whale oil soap solution, when the buds burst and again as soon as the leaves have expanded.

The Seventeen-year Locust or Cicada: (*Tibicen septendecim* Linn.) These periodical insects do considerable damage to young trees by depositing their eggs in the twigs and limbs, which are often broken and stunted by this injury. They do not heal for years, and leave places where disease germs enter. The nymphs live under ground on the roots of trees and bushes.

Treatment: Prune thoroughly such trees as are injured, and destroy the removed twigs and branches. Avoid planting the year before "locust year" in your locality. Do not prune during the year before the "locusts" are due.

III. Plant Diseases.

Baldwin Fruit Spot: (*Cylindrosporium Pomi* Brooks.) This disease is so-named because the Baldwin is especially susceptible, but most northern-varieties are more or less effected by this disease. This, or similar trouble, is the worst enemy of the Jonathan. It appears on the fruits about the middle of August, as a minute spot of a color somewhat darker than that of the surrounding skin. As the apples mature the irregular spots enlarge, become sunken and dark brown to black. The fungus involves the flesh beneath the skin, thus reducing the market value of the fruit, although not materially injuring it for practical uses.

Treatment: Spray with Bordeaux mixture (42 b), or lime-sulphur solution (1 gal. and 1 pt., in 49 gal. water) in the beginning of July.

Bitter Rot: [*Glomerella rufomaculans* (Berk.) Spauld. & von Schrenk.] This disease first makes its appearance on the apple in the form of small brown spots in the skin. Under conditions favorable to the development of the fungus, such as warm, sultry and wet weather, the spots increase rapidly in size, always showing a well-defined circular margin. When about one-fourth inch in diameter, the affected area becomes sunken and shrivelled. Later the dried or mummied fruits drop, or they may remain hanging on the trees

throughout the winter. Even the apparently unaffected flesh of a diseased apple has a distinct bitter taste. The bitter rot fungus also affects the bark, causing a canker.

Treatment. Pick and destroy (by burning or burying) all mummied fruits. Prune out all cankered limbs. Spray with Bordeaux mixture (42 b) at least four times during the growing season. The first application should be made about forty days after the petals fall. Subsequent sprayings should be made at intervals of two weeks or, during very wet weather, every ten days.

Black Rot: (*Sphæroopsis Malorum* Pk.) The Black Rot is a common disease of pome fruits—apple, pear, and quince. It affects fruit, leaves and limbs. A rough canker is formed on the limbs, while spots appear on the leaves. On the fruit the rot begins as a small spot, generally near the flower end, and spreads until the whole fruit is involved. When the rot is about a half inch or more in diameter, small spore pustules develop on its surface. The affected tissues do not shrink,—but remain full and thus present a distinction from Bitter Rot.

Treatment: Keep the orchard in good condition and properly pruned, being careful to remove all cankered limbs. Destroy effected fruits. Spray with lime-sulphur solution in the spring before the buds burst, and with dilute lime-sulphur or Bordeaux, during the summer.

Brown Rot: [*Sclerotinia fructigena* (Pers.) Schroet.] See under PEACH).

Crown Gall: (*Pseudomonas tumefaciens* Erw. Smith & Townsend.) This is a bacterial disease which produces rough corky enlargements, or knobs on the roots, and crowns of plants, particularly the pomaceous, stone, and bush fruits,—which belong to the Rose family (Rosaceæ). Generally speaking, nursery stock is more readily affected than older trees. The gall is a cancerous production within the cambium, or growing layer. Generally each season's growth dies and disintegrates before the following spring. It continues to spread from year to year and stunts the growth of the tree. Although there is considerable difference of opinion as to the seriousness of the depredations of *Crown Gall*, it is best to plant only trees that are free from gall, and use no grafts, buds or cuttings from gall-infested trees.

Treatment: Efforts to cure affected trees by cutting out the galls are not successful. Therefore, the following suggestions are of importance. Examine all nursery stock carefully and discard trees showing the presence of galls. It is believed that infection gains entrance to the trees through wounds, so that care should be taken to avoid any injury to trees at the surface of the ground when cultivating. If the gall is around the crown of any growing tree destroy it by burning, and plant another in its place.

Pink Rot: (*Cephalothecium roseum* Cda.) In the autumn apples infected with scab often have developed on these affected areas what is known as Pink Rot. This is a saprophytic fungus and appears as a mold. This is especially marked on scabby apples after harvesting.

Treatment: It is plain that since the Pink Rot is subsequent to and dependent upon apple scab, the most effective control measure is to prevent the formation of Scab as directed below.

Rust: (*Gymnosporangium macropus* Lk.) This common disease lives during the summer on the apple trees, producing orange-colored blotches on the leaves and fruits. One of the essential stages of its life is passed on the red cedar, on which the disease forms knots, called cedar-apples.

Treatment: Destroy all red cedars in the neighborhood. Spray with Bordeaux mixture (42 a), or self-boiled lime-sulphur (35) as soon as the petals fall and again in two weeks.

Scab: [*Venturia Pomi* (Fr.) Wint.] Apple scab affects both the leaves and fruits and may often be found on petioles (or leaf stems), flowers, and twigs. On the leaves the scab appears as a velvety, greenish spot, most abundant on the under side. On the fruit it develops as small circular, olive-green spots, which spread, crack open, roughen the surface of the skin, and distort the fruit.

Treatment: Spray with lime-sulphur solution (34), or Bordeaux mixture (42 a), just before the buds open. After the petals have just fallen, and again in ten days or two weeks spray with Bordeaux Mixture (42 a), or self-boiled lime-sulphur (35).

Sooty Blotch or Fly-speck Fungus: [*Leptothyrium Pomi* (Mont. & Fr.) Sacc.] These are two stages of the same fungus, and invariably are found on the same plant and the same portion of it. The disease is readily recognized by the fruit looking as though rubbed with soot, or sprinkled with fly specks, and the common names are suggestive of the appearance of diseased fruit just before ripening.

Treatment: Spray with Bordeaux Mixture (42 a), or self-boiled lime-sulphur solution (35), ten days after the petals drop and ammonical copper carbonate (43), when fruits are half grown, and again two weeks later. Prune to give light and ventilation.

Pear Blight, Twig Blight, Fire Blight, Black Blight, Body Blight, or Collar Blight: [*Bacillus amylovorus* (Burr.) De Toni.] This is a bacterial disease which affects the pear in particular, but is also found on the apple and quince. It appears mostly in the spring, when it is recognized by the scorched appearance of the leaves and the blackened, dead appearance of the twigs. It is seen mostly on the twigs, but does sometimes spread to the larger branches, the trunk, or even the roots. In the form commonly called "Collar Blight," at the crown it is the worst disease of the apple tree; and as "Twig

Blight" it is the worst disease of the pear and quince. The disease is carried from affected to healthy trees by various agencies. Infection takes place readily during the blossoming period.

Treatment: The most effective remedy is to remove most carefully all infested parts of trees, cutting back at least a foot below the injury. Carelessness in pruning serves to spread the disease. It is advisable to go over the trees several times to be sure of having removed all infected parts. Sterilize pruning instruments between cuts by passing through flame or washing with weak formalin solution. For Collar Blight mound with earth mixed with a little powdered sulphur.

IV. Other Enemies.

Leaf Blister-mites: (Acarina.) In the spring small mites burrow into the leaves to deposit their eggs. The point of entrance is red at first, but finally turns black. The young mites feed within the leaf on the parenchyma, or soft tissue. The adults hibernate on the twigs and around the scales covering the buds.

Treatment: Spray in the spring, before the buds burst, with kerosene emulsion (32 a), or lime-sulphur solution (34), or whale-oil soap solution (33 b). When especially detrimental to trees prune closely in winter and burn the twigs.

Ground-hogs or Wood-chucks: [Arctomys monax (Linn.)] These mammals are often quite destructive to young orchards where their injuries consist of irregular gnawing of the bark during the summer.

Treatment: Ground-hogs can be killed by saturating a wad of cotton with carbon bisulphite (37) and pushing this into the burrow. Then close the opening with earth to keep in the fumes.

Mice: (Muridæ) Mice are frequently very injurious in young orchards, gnawing bark on the trunks especially during winter when the snow remains on the ground for a considerable time.

Treatment: Since the mice run about under the surface of the snow and do not gnaw the bark above it, their injury can be prevented by tramping the snow firmly about the trees. Barriers, such as wire netting placed around the trees, prevent the approach of the mice. Make a mound of earth six inches high around each tree in the fall. By keeping the orchard free from weeds and grass the mice will have no hiding places. Poisoned baits (30 b), traps, and cats are effective remedies. Weasels, hawks, owls, and shrikes are their chief natural enemies.

Rabbits: (Pepus nuttalli mallurus Thomsa.) Like mice, rabbits are especially troublesome in orchards in winter. When snow remains on the ground for a long time these mammals have difficulty in finding food and resort to girdling the trees to secure the bark.

Treatment: Damage from rabbits may be prevented by protecting the trunk with a coating of pure white lead and raw linseed oil paint, with wire netting screen, wooden veneer, tar paper, or blood. Trees damaged by rodents should have the injured surface coated with grafting wax, covered with clay, and then wrapped with cloths. Bridge-grafting may be resorted to in early spring. Drop on the snow some branches cut from older trees, to feed the rabbits. Get hunters after them.

THE APRICOT.

I. *Chewing Insects.*

The Peach-tree Bore. (*Sanninoidea exitiosa* Say.) See under peach).

The Plum Curculio. (*Conotrachelus nenuphar* Hbst.) (See under cherry).

II. *Sucking Insects.*

Aphids. (Aphididæ.) (See under apple).

The Lecanium Scale. (*Eulecanium* sp.) (See under peach).

The San José Scale. (See under apple).

III. *Plant Diseases.*

Brown Rot or Monilia Rot. (See under peach).

Crown Gall. (See under apple).

Scab: (*Cladosporium carpophilum* Thüm.) This fungus produces the familiar small, circular, dark-brown to black, or greenish, or cloudy spots on peaches and apricots. These spots are usually confined to one side of the fruit and often make it crack or split. They develop on the leaves also, where they later fall out, thus producing a shot-hole effect.

Treatment: Prune trees so as to admit the sunlight freely. Spray with lime-sulphur solution (34), or Bordeaux mixture (42 a) immediately before the buds open in the spring and with self-boiled lime-sulphur solution (35), extra dilute lime-sulphur (1 gal. and 1 pt. in 49 gal. water), or potassium sulphide (44), soon after the husk or collar drops from the fruit.

Shot-Hole Fungus: Closely allied to the leaf spot of the cherry, which see.

ASH.

I. *Chewing Insects.*

Borers: (Buprestidæ.) These are closely allied to the flat-headed borers of the apple, which see.

Leopard Moth: (*Zeuzera pyrina* Fab.) (See under "Poplar").

Caterpillars: (Lepidoptera.) Several species of caterpillars feed upon the leaves of the ash.

Treatment: If tent caterpillars be present destroy the webs first. Spray with lead arsenate (27 a) or Paris green (26 a) when the larvæ are young and feeding voraciously.

Gall-louse: (Aphididae). This is a plant louse or aphid which in depositing its eggs in the leaf so affects the latter as to produce a tubercle-like structure called a gall. In these the young develop.

Treatment: If detrimental to the tree, gather all infested leaves and burn.

The Saw-fly: (Hymenoptera.) The saw-flies are insects belonging to the same order as the wasps and bees. They possess four wings and in this respect differ from the true flies which possess but two. The saw-flies are so-called because the female is provided with a pair of saw-like structures, by means of which she makes slits in leaves and stems of plants. The eggs are deposited in these slits. The larvæ resemble superficially the caterpillars of moth and butterflies, but generally have the peculiar habit of curling the posterior part of the body to one side.

Treatment: Spray with arsenate of lead (27 a), or Paris green (26 a).

II. Sucking Insects.

Aphids. (Aphididæ). (See under Apple).

The Oyster-shell Scale. See under apple).

III. Plant Diseases.

Decay or Brown Rot: [*Polyporus sulphureus* (Bull.) Fr] Brown rot is a fungus disease, which attacks a wide variety of deciduous trees and some conifers. The spores gain entrance through wounds, knot-holes and other exposed surfaces. As the plant grows, it extends its fibers, (hyphæ of the mycelium) deeper and deeper into the tree until the heart wood is reached. The disease would scarcely be detected from the outside if it were not for the development there, of the brilliant sulphur-yellow sporophores, in which are produced myriads of minute spores. The mycelium kills the tissue of the tree as it progresses, and decay is the direct result.

Treatment: To prevent the entrance of spores, cover all injured or otherwise exposed surfaces with house paint, tar, lime-sulphur solution or other antiseptic liquids promptly. Destroy the sporophores which appear, so as to prevent the spread of the spores to new seats of infection. Cut out all rotting parts and fill cavities with cement made of Portland cement, 1 part, and clean sand three parts.

White Rot: [*Polyporus squamosus* (Huds.) Fr.] The fungus which produces White Rot seems to occur in many species of deciduous trees and is closely related to the preceding. It, too, kills the tree as its mycelium is extended, but the dead wood remains light in color.

Treatment: Same as for *Brown Rot*, which see.

BARBERRY.

III. *Plant Diseases.*

Rust: (*Puccinia graminis* Pers.) The rust, which occurs upon the barberry is perhaps the most important rust from the economic standpoint. This fungus lives on the leaves of barberry, where it forms cluster cups. Later æcidia are formed and break through the epidermis of the leaf in the same locations as did the clusters cups. These æcidia break and liberate numerous spores, which are carried by the wind and find lodgment in cereals, such as wheat, oats, rye, barley, and other grasses. On these the spores grow and produce the *Black Rust* of grain.

Treatment: The most effective remedy for black rust is to destroy all barberry plants. In that way the rust is deprived of one essential host and cannot develop, since two hosts are required.

BEECH.

I. *Chewing Insects.*

The Beech-leaf Miner: This insect is closely allied to the Leaf Miner that infests locust, which see.

Caterpillars: (*Lepidoptera*.) (See under ash.)

II. *Sucking Insects.*

The Beech Aphis. (*Aphididæ*). (See "Aphis" under apple).

Wolly Aphis. (*Aphididæ*). (See "Aphis" under apple).

III. *Plant Diseases.*

Decay: [*Fomes fomentarius* (L.) Fr.] The decay of beech is due to a fungus. See general discussion under *Brown Rot of Ash*. In the case of the particular disease in question, the sporophore, which forms on the bark is hoof-shaped; the upper surface is gray and the under surface, brown.

Treatment: (See under *Brown Rot of Ash*).

Heart Rot: [*Fomes ignarius* (L.) Gillett.] This disease is most prevalent in moist forests and occurs in beech, maple, yellow birch, and certain oaks. The mycelium, or vegetative part of the plant, lives in the heart wood, which it converts into a spongy mass.

The sporophores, which appear on the bark are hoof-shaped and perennial, so that the brackets grow to considerable size. The upper surface is black and becomes cracked with age.

Treatment: There is no practical method of control in forests. Forest trees used for shade purposes are scarcely ever seriously affected. (See *Brown Rot of Ash*).

BIRCH.

I. *Chewing Insects.*

Borers: The birch is subject to the attack of both flat-headed and round-headed borers, as is the apple, which see.

Caterpillars. (Lepidoptera). (See under ash).

Leaf-rollers. (Lepidoptera). (See under apple).

Saw-flies. (Hymenoptera). (See under ash).

The Pigeon Tremex: (*Tremex columba* Linn.) The Pigeon Tremex is an insect whose body is about one and one-fourth inches long and black with yellow bands and spots; the wings are smoky color, but transparent, and the legs are yellow. The eggs are deposited in the wood. The grub is about one and one-half inches in length, white and cylindrical. The pupal stage is passed in the tree.

Treatment: No practical method of combating the Pigeon Tremex is known, but parasites help to keep them in check. However, the Tremex attacks only declining trees, so that we can lessen the danger of attack by keeping the trees in a healthy condition. Woodpeckers should be preserved, and the Long-tailed Ichneumon Fly is its natural enemy.

II. *Sucking Insects.*

Leaf-hoppers. (Jassoidea). (See under apple).

Aphids. (Aphididæ). (See under apple).

III. *Plant Diseases.*

Decay. [*Fomes fomentarius* (L.) Fr.] (See under Beech).

CATALPA.

I. *Chewing Insects.*

The Catalpa Sphinx: (*Ceratonia catalpæ* Bdv.) The larvæ of this moth are recognized by their distinctive black and yellow coloration. They feed in colonies and are often very destructive to catalpa trees.

Treatment: Prompt applications as sprays of lead asenate (27 a), or Paris green (26 a) are effective.

III. *Plant Diseases.*

Leaf Blight: (*Macrosporium Catalpæ* Ell. and Mart.) and **Leaf Spot** (*Phyllosticta Catalpæ* Ell. and Mart.) These two diseases of the leaves of *Catalpa* are caused by fungi which are often associated on the same leaves. One causes the leaf to dry and die from its edges, and the other causes round dead spots. Several species of *Catalpa* are subject to attack.

Treatment: Spray with Bordeaux mixture (42 a) before the buds burst.

CEDAR AND CYPRESS.

I. *Chewing Insects.*

The Bag Worm. (*Thyridopteryx ephemeræformis* Steph.) (See under apple.)

The Fir Saw fly. (*Hymenoptera*). (See under ash).

III. *Plant Diseases.*

Rust or Cedar Apple. (*Gymnosporangium macropus* Lk.) (See under apple.)

White Rot. (*Polyporus Juniperinus* von Schrenk). (See under ash).

CHERRY.

I. *Chewing Insects.*

The Plum Curculio: (*Conotrachelus nenuphar* Hbst.) This insect is similar to the curculios which affect the apple. The larvæ infest the fruit of peach, plum cherry, and apricot, eating away the flesh next the pit or seed, thus causing the fruit to drop prematurely.

Treatment: Spray with 3 lbs., arsenate of lead in fifty gallons liquid just after the husks drop. Destroy wormy or fallen fruits. (Also see under *Apple*).

Leaf Slugs. (*Caliroa limacina* Retz.): The slug is a greenish black slimy "grub" which feeds upon the upper side of the leaf, which it skeletonizes by eating the parenchyma. It is the larva of a saw fly.

Treatment: Sprinkle infested leaves with hellebore (31 b) or with lime (freshly slaked, or Paris green (26 a), or arsenate of lead (27 a).

Shot-hole Borers: (See under *Scolytid bark beetles of apple*.)

II. *Sucking Insects.*

Cherry Aphids (*Myzus cerasi* Fabr.): These are brown and black species of plant lice. They confine their attacks to young twigs and the under side of leaves. They puncture the leaf to withdraw the sap, so that growth is arrested, the leaves curl, and finally drop prematurely. The growth of the shoot is also stopped.

Treatment: Same as for the green apple aphid, except that solutions should be a little stronger for the black and brown species.

The European Fruit-Scale. (*Aspidiotus ostreæformis* Curt.): Similar to San José Scale, but its tip is not in the center and has no groove around it. Not so destructive as San José, and does not multiply as rapidly.

Treatment: Same as for San José.

The San José Scale. (See under apple).

The Woolly Aphid. (See under apple).

III. Plant Diseases.

Black Knot. [*Plowrightia morbosa* (Schw.) Sacc.]: This malady is one of the commonest and most unsightly diseases of the cherry and plum. It is characterized by black wart-like developments of the woody parts of the tree. These knots are generally confined to one side of a twig or branch. They make their appearance in spring as slight swellings. By mid-summer these are full-grown, black and dry.

Treatment: Cut out and burn all diseased portions, cutting six or eight inches below the knot, in the spring of the year and at such times as other knots may develop. Paint the cut end with a disinfectant solution (see under pear blight, apple), or use house paints. Spray with Bordeaux mixture (42 a) during the late winter and when the buds begin to swell; or with lime-sulphur as for San José Scale; follow this with a spray of Bordeaux mixture (42 a) as soon as the petals drop, and again ten days or two weeks thereafter.

Brown Rot. (See under peach).

Crown Gall. (See under apple).

Leaf Curl and Witches' Broom: (*Eroasus Cerasi* Fuckel): This fungous disease occurs in both the branches and leaves of the cherry. The branches are so affected that numerous twigs are produced to form a loose broom; while the leaves become crumbled and reddish.

Treatment: Destroy all affected branches by burning. Spray with Bordeaux mixture (42 a) in fall and again in the spring before the buds burst.

Leaf Spot (*Cylindrosporium Padi* Karst and *Mycosphaerella Cressella* Aderh): The leaf spot of the cherry and plum is caused by several species of fungi but in all cases the effect is practically the same. These affected areas of leaves die, become dry and finally drop out, thus producing the familiar shot-hole effect. These spots may be so numerous as to run together, in which case the leaves are so affected as to become yellow and fall.

Treatment: Spray with Bordeaux mixture (42 a) or dilute lime-sulphur solution (one gallon and one pint in forty-nine gallons water) before the buds open in the spring. Spray with dilute lime-sulphur solution (34) or home-boiled lime-sulphur solution (35) as soon as the fruit is well set.

Root Rot. (*Armillaria mellea* Vahl. and *Clitocybe parasitica* Wilcox): The rotting of the roots of deciduous trees including fruit-bearers is attributed to the invasion of fungi, whose sporophores are of the form of mushrooms.

Treatment: Since the fungi are enemies to forest trees as well as fruit trees, it is advisable to remove all stumps and roots in land set to orchards. As a further preventive allow a lapse of several years before planting fruit trees in new ground by cultivating such land and sowing to field crops. Destroy affected trees.

Scab: (See under apricot).

CHESTNUT.

I. Chewing Insects.

Caterpillars. (See under apple).

The Chestnut-leaf Miner—(*Phyllonoryter* sp.): The chestnut is attacked by several species of leaf-miners, including one species of *Bucculatrix* (see under apple). However, most of them are typical miners, so to speak, and spend the whole feeding period within the leaf.

Treatment: Destroy infested leaves. Spray about the first of July with lead arsenate (27 a) or Paris green (26 a).

Chestnut Tree-Borer. (See under apple).

The Chestnut Weevil (*Balaninus proboscoideus* Fab.): These are insects that cause "wormy" chestnuts. The adult is a small snout beetle which lays its eggs in the nuts just before they ripen.

Treatment: All worms and wormy nuts should be destroyed. All nuts should be fumigated with carbon bisulphide (37) or hydrocyanic acid gas (38) in order to kill the larvæ or "worms" which they contain. If carbon bisulphide be used, place the nuts in a wash boiler or barrel and place the vessel containing the liquid on top of the nuts. Close the container tightly for three or four hours. Ventilate the nuts thoroughly before using.

II. Sucking Insects.

Chestnut Aphids. (See under apple).

The Chestnut Tree-hopper (*Membracidæ*). (See under tree-hopper of apple).

III. Plant Diseases.

The Chestnut Blight or Bark Disease (Diaporthe parasitica Murrill.): This disease is caused by a fungous parasite. The growth of the parasitic plant in the inner bark produces lesions which girdle the trunk or limbs, thus causing the death of the portion of the tree beyond immediate point of attack. From these lesions arise numerous fruiting bodies which are of a yellow to reddish-brown color according to age, and the size of a pin head (made up of winter spores) or in the form of "strings" (made up of summer spores). The presence of the disease is further shown by (1) the production in spring of half-grown yellow leaves on previously girdled branches, (2) reddish-brown leaves on branches girdled in summer and (3) the appearance of water sprouts below the lesions.

Treatment: Keep close watch for affected trees, especially those which are in advance of the main body of trees. Defer planting nursery stock indefinitely or plant trees which have been inspected rigidly. In the case of infected trees the diseased portion should be removed thoroughly. Parts of trees thus exposed should be covered with tar or other antiseptic dressing. Badly infected trees should be cut down, the bark removed and burned over the stump. The wood may be manufactured into lumber. All infected parts of trees should be burned.

Crown Gall. (See under apple).

ELM.

I. Chewing Insects.

The Elm Span-worms (Geometroidea): Several species of span-worms or measuring-worms, feed upon elm leaves and are recognized by their characteristic method of progression, which is suggested by their common names.

Treatment: Spray with lead arsenate (27 a), or Paris green (26 a), when the larvæ are actively feeding.

The Elm-tree Borers (Saperda tridentata Oliv.): Elm trees are attacked by the larvæ of long-horned beetles known as *flat-headed borers*. Allied species have already been considered under various plants.

Treatment: (See under apple).

Canker-worms (Alsophila pometaria Peck.): The *full canker-worms* are larvæ of species belonging to the measuring worm family and feed upon a variety of deciduous trees such as oak, elm, hickory, apple, and linden.

Treatment: (See under apple).

The Imported Elm-tree Beetle (Galerucella luteola Müll.): This is a greenish yellow insect about one-third of an inch in length with two black stripes on its wing covers. It hibernates in the adult stage and feeds upon the young leaves in the early spring. The female lays rows of yellow eggs on the under side of leaves. From these eggs hatch yellow, black-spotted, hairy larvæ, which destroy the foliage.

Treatment: Spray with arsenate of lead (27 a), or Paris green (26 a) before the leaves are fully grown, and repeat as soon as the young larvæ appear. Paint a band of coal tar about a foot wide around the trunk of the tree at its base, the first of March.

The Pigeon Tremex. (See under Birch).

II. Sucking Insects.

Aphids. (See under apple).

Cock's Comb Gall Louse (Colopha ulmicola Fitch.): This is a species of plant louse, which deposits its eggs in the tissue on the upper side of the leaf. Around the larvæ forms a fibrous growth one inch long and a half inch high, somewhat resembling a cock's comb.

Treatment: Gather and burn all infested leaves.

Wooly Aphis. (See under apple).

III. Plant Diseases.

Blister Canker. (See under apple).

White Rot. (See under ash).

FIR.

I. Chewing Insects.

Borers. (See under apple).

Caterpillars. (See under Ash).

The Fir-needle Inch Worm (Geometroidea): Several species of measuring worms infest the coniferous or evergreen trees.

Treatment: (As for caterpillars, which see under ash).

The Fir Saw-Fly. (See under ash).

White-marked Tussock Moth. (See under apple).

II. Sucking Insects.

The Lecanium Scale. (See under apricot).

III. Plant Diseases.

Rust. (See under apple).

IV. *Other Enemies.*

The Fir Mite: A Mite, or so-called "Red Spider," attacks the foliage and makes it turn gray.

Treatment: Spray with extra-dilute lime-sulphur solution, or with potassium sulfide (1 oz. in 1 gal. water).

HEMLOCK.

I. *Chewing Insects.*

Borers. (See under apple).

Caterpillars. (See under ash).

II. *Sucking Insects.*

The Hemlock Leaf-scale (Aspidiotus abietis Schr.): This is a scale insect, which lives upon the needles of fir, pine, and hemlock and often becomes very detrimental to the tree by sucking out the sap.

Treatment: Spray with lime-sulphur solution as for San José Scale.

III. *Plant Diseases.*

Decay. (See under Ash).

Dry Rot. [Trametes Pini (Brot.) Fr.]: Practically all coniferous trees are subject to the attacks of a certain fungus which destroys the wood. Numerous pits or pockets are formed and in these it is found that the wood has been so altered that it is in the form of bleached "punk". The sporophore generally arises at a wounded area and is either a dark brown layer or a hoof-shaped bracket. As these sporophores are perennial they increase in size from year to year.

Treatment: As infection takes place through exposed surfaces, the first step toward eradicating the dry rot is to prevent exposure by injury. Destroy diseased trees and the sporophores. Cover exposed surfaces with paint (pure white lead and raw linseed oil), or with asphaltum, or tar. (See under Chestnut Blight).

HICKORY.

I. *Chewing Insects.*

Caterpillars. (See under ash).

The Hickory Bark-borer (Scolytus quadrispinosus Say.): This insect is closely allied to the Shot-hole Borer of fruit trees. (See under Cherry).

Borers. (See under apple).

The Hickory-nut Weevil (*Balaninus caryæ* Horn.): This beetle is very similar to the weevils that infest chestnuts. (See chestnut weevil).

The Hickory Tussock Moth (*Halisidota caryæ* Harr): This moth is closely allied to the white marked species described under the apple, which see.

The Hickory Twig-girdler (*Oncideres cingulatus* Say.): This beetle after depositing an egg in the twig, girdles the latter a short distance below the egg. The circle causes the death of the twig above the girdle, so that the leaves wither and the twig breaks and falls. In this way the presence of the larvæ is made known.

Treatment: Cut off and burn infested twigs at a time when they contain the larvæ, or gather and burn them as soon as they fall.

Tree Hoppers. (See under apple).

Slug-worms. (See under leaf slug of cherry).

The Walnut Case-bearer (*Mineola juglandis* Le Baron): The larvæ of this species of moth form dark brown cases on hickory leaves. The species is closely allied to the case-bearer of the apple, which see.

The Walnut Leaf-roller. (For treatment see under leaf roller of apple).

The Walking Stick (*Diapheromera femorata* Say.): This odd insect, sometimes called the "Devil's Darning Needle," is not generally abundant in any one locality, although it is widely distributed. When at rest, the walking-stick is easily overlooked so closely does it resemble a twig. It drops its large eggs on the ground or leaves under trees, or plants where it feeds on foliage.

Treatment: Should walking sticks become so abundant as to defoliate trees badly they can be checked by spraying with lead arsenate (27 a), or Paris green (26 a).

II. Sucking Insects.

The Hickory Aphis. (See under apple).

III. Plant Diseases.

Root Rot. (See under cherry).

HORSE CHESTNUTS.

I. Chewing Insects.

Caterpillars. (See under ash).

The Buckeye Stem-borer. (For treatment see Borers of Apple).

II. Sucking Insects.

The Oyster Shell Scale. (See under apple).

The Lecanium Scale. (See under apricot).

III. Plant Diseases.

Leaf Blotch (Phyllosticta Paviae Desm): As the season advances the leaves of horse-chestnut trees frequently develop irregular spots, which may eventually cover the whole leaf. The leaves become yellow and fall prematurely, so that the tree is much depleted in vitality. The disease is caused by a fungus.

Treatment: Gather and burn all infected leaves as they fall. Spray, as the buds begin to open, with Bordeaux mixture (42 a).

Tip Burn: Tip burn, or Leaf Blight, is a common trouble with leaves of horse-chestnut in summer. The leaves turn brown and drop, due to insufficient water and food. Prune back and water with an ounce of nitrate of soda in each bucket of water.

JUNIPER.

I. Chewing Insects.

Bag-worms. (See under apple).

The Blue Pine-borer. (For treatment see Borers, under apple).

Caterpillars. (See under ash).

The Juniper-twig Inch-worms. (For treatment, see Canker Worms under apple).

The Juniper Bark-borer. (For treatment, see Shot-hole Borer, under peach).

II. Sucking Insects.

The Juniper Scale. Several species of scale insects infest the Juniper. Young nursery stock is especially liable to attack.

Treatment: (As for Lecanium Scale, which see under apricot).

III. Plant Diseases.

Rust. (See under apple).

LARCH.

I. Chewing Insects.

Caterpillars. (See under ash).

The Larch Lappet Moth (Tolyte laricis Fitch): In the larval stage this moth is a tent caterpillar. It feeds upon larch, pine, and hemlock. The caterpillar is of a dull brown color and one and one-half inches in length. It reaches full growth during July. The moths appear in August or September.

Treatment: (See tent-caterpillar under apple).

The Larch Saw-fly. (This insect is closely related to the saw-fly of the ash, which see).

Tussock Moths. (See under apple).

II. Sucking Insects.

The Larch Chermes (*Chermaphis laricifoliæ* Fitch.) This is a species of plant louse, which occurs on larch and tamarack.

Treatment: As for aphids. (See under apple).

The Larch Aphid. This form is closely related to the above. Treatment similar.

III. Plant Diseases.

Canker (*Dasyctypha Willkommii* Hartig): This canker is a typical one. It gains entrance through wounds and rapidly causes the bark to become shrunk and brown and to die. The canker growth is most rapid during autumn and winter.

Treatment: The disease is most apt to be disastrous in moist, marshy situations. Larch trees on dry slopes seem to be attacked seldom. These points should be borne in mind as no practical methods of eradicating larch canker are known.

Decay. (See under ash).

Dry Rot. (See under hemlock).

Root Rot. (See under cherry).

LILAC.

I. Chewing Insects.

Borers. The larvæ of certain clear-wing moths (Sesiidæ) frequently prove destructive to lilac.

Treatment: Infested shoots should be cut out and burned as soon as observed.

II. Sucking Insects.

The Oyster Shell Scale. (See under apple).

The San José Scale. (See under apple).

III. Plant Diseases.

Powdery Mildew [*Microsphaera Alni* (Wallr.) Wint.]: In late summer a mildew frequently develops on the leaves of lilac, causing the leaves to become gray. In some cases this mildew is confined to patches, but generally covers the entire leaf.

Treatment: Spray as soon as the leaves open with Bordeaux mixture (42 a), or lime-sulphur solution (34; 1 gal. & 1 pt. to 49 gallons of water), or use sulphur dust, or one ounce of Potassium sulfide in each gallon of water. Repeat in six weeks.

LINDEN or BASSWOOD.

I. *Chewing Insects.*

The Linden Borers: Several species of round headed borers,—larvæ of long-horned beetles (Cerambycidæ), principally *Saperda vestita* Say)—pass the larval and pupal stage in the linden,—also the larva of the Leopard Moth (*Zeuzera pyrina* Fab.).

Treatment: (See Borers under apple).

The Linden Leaf-Beetle: Allied to the leaf-beetle affecting the elm, which see.

The Leopard Moth (Zeuzera pyrina Fab.): This is an introduced species, which attacks a variety of trees, both shade and fruit. The adult is white, with numerous small black spots. The larva lives in the woody tissue of the host, in which it bores.

Treatment: As for borers, which see under apple).

The White-marked Tussock Moth. (See under apple).

The Fall Web-worm. (See under elm).

The Pigeon Tremex. (See under birch).

II. *Sucking Insects.*

San José Scale. (See under apple).

III. *Plant Diseases.*

White Rot. (See under ash).

IV. *Other Enemies.*

The Gall-mite. (See treatment of Cock's Comb Gall of Elm).

LOCUST.

I. *Chewing Insects.*

The Bag-worm. (See under apple).

Caterpillars. (See under ash).

The Locust Leaf-rollers. (See leaf-rollers under apple).

The Locust Leaf-miner (Odontota dorsalis Thumb.): The adult insect is a brown and black striped beetle about one-fourth inch in length. The general color of the insect is red, while the legs, head, and a line running the length of the body are black. The eggs are laid on the leaves. In these the larvæ live upon the parenchyma or middle layer. Pupation takes place within the leaf and the adults are also leaf-eaters. They are the pests which cause locust trees to look brown in mid-summer.

Treatment: Spray the leaves as soon as the mature insects appear, with lead arsenate (27 a), or Paris green (26 a).

The Locust Borer (Cyllene robiniae Forst.): This is one of the most serious pests of the locust. In many localities it is difficult to find a sound tree. The adult is a Long-horned Beetle, black, with yellow lines and one and a quarter to one and a half inches in length. They deposit eggs singly in the bark about the latter part of July. The larvæ bore in the wood and appear as adults the following year.

Treatment: (See Borers under apple).

For all borers the best preventive is the presence of Woodpeckers of all kinds.

The Locust Saw-flies. (See Saw-fly under ash).

II. Sucking Insects.

The Rapacious Scale. (Treatment as for San José Scale, under apple).

III. Plant Diseases.

Decay or Brown Rot. (See under ash).

MAPLE.

I. Chewing Insects.

Caterpillars. (See under ash).

The Flat-headed Apple-tree Borer. (See under apple).

The Maple Leaf-miner. (See under ash).

The Pigeon Tremex. (See under Birch).

Saw-flies. (See under ash).

The Sugar Maple Borer (Plagionotus speciosus Say.): The adult is a long-horned beetle, and the larvæ is a round-headed borer. They frequently infest sugar maples so badly as to prove very injurious.

Treatment: (See under apple).

II. Sucking Insects.

The Cottony Maple Scale (Pulvinaria innumerabilis Rathv.): This insect is readily recognized by the fact that it secretes a substance, which forms a cottony mass under the scale. The eggs, found with the mass, hatch in early summer and the young migrate to the leaves and young twigs, from which they suck the sap. In the fall, the partly grown young return to the branches and in the spring are mature. The species is usually found on soft and hard maple, but also occurs on other shade trees and on vines.

Treatment: (As for San José Scale, which see under apple).

The Gloomy Scale (Chrysomphalus tenebricosus Comst.): The gloomy scale appears to be most prevalent on the red maple.

Treatment: (As for San José Scale, which see under apple).

The Maple Aphis (*Chaitophorus aceris* Linn.): The Norway Maple Aphis would appear to be very injurious at times. The honey dew which they secrete, often becomes very conspicuous on the trees, and falls to the ground beneath. A smutty fungus develops in this, and some leaves fall so owners of Norway Maple Trees often become alarmed. The danger, however, is more apparent than real. It does not seriously injure the trees to lose a few leaves.

Treatment: If the trees should require attention, the aphids can be held in check by spraying with whale-oil soap solution (33 b), or laundry soap solution (33 a).

The Maple Lecanium or Terrapin Scale (*Eulecanium nigrofasciatum* Perg.): The insects commonly called "terrapin" scale, are of the size and shape of a small split pea and brown in color. They pass the winter three-fourths grown. The young appear in July as free-moving, minute, soft-bodied insects.

Treatment: When the young appear, spray infested trees with kerosene emulsion (32 c), or soap solution (33 b), or tobacco decoction (41 a). Spray during dormant season with kerosene emulsion (32 a), or lime-sulphur solution (34), or strong whale-oil soap solution (1 lb. soap to 2 gal. water). Paint infested areas at any time with very strong soap solution, applied with a brush.

The Oyster Shell Scale. (See under apple).

III. Plant Diseases.

Anthracnose (*Glæosporium apocryptum* E. & E.): Norway Maple Trees in the nursery are often badly infested by a fungus closely related to that which causes the anthracnose of raspberry and blackberry. It occurs as light spots in the leaves and young twigs.

Treatment: Spray thoroughly with Bordeaux mixture in the early season. Cut off and destroy diseased twigs.

Decay. (See under Beech).

Gall (*Pycnochytrium globosum* Schroet.): Small yellow or red galls, are sometimes formed on maple seedlings by a fungus, which gains entrance into the epidermis.

Treatment: Avoid planting seedlings affected with gall. Burn affected seedlings.

Heart Rot. (See under Beech).

Leaf Blotch [*Rhytisma Acerinum* (Pers.) Fr.]: Conspicuous black spots are frequently seen on the leaves of maple. The spots first appear as yellow, thickened areas. Later these become black and tough. The disease is not generally considered injurious.

Treatment: As a control measure, the affected leaves should be burned, since development of the fungus continues even after the leaves fall. Spray with Bordeaux mixture as soon as the buds burst in the spring.

Powdery Mildew. (See under lilac).

White Rot: (See under ash).

IV. Other Enemies.

Gall-mites (Acarina): Galls are often formed on the leaves by mites. Gather and burn the infested leaves as soon as they fall.

MOUNTAIN ASH.

I. Chewing Insects.

Borers. (See under apple).

The Leopard Moth. (See under Linden).

II. Sucking Insects.

The Oyster Shell Scale. (See under apple).

The San José Scale. (See under apple).

The Scurfy Scale. (See under apple).

III. Plant Diseases.

Rust (Gymnosporangium globosum Farl.): The fungus which produces the rust on the mountain ash, is closely related to that which infects the apple.

Treatment: The rust of the mountain ash and apple, are so similar in form and habit, that the same method of treatment is applicable to both. (See under apple).

OAK.

I. Chewing Insects.

The Carpenter Moth (Prionoxystus robinia Peck): This species is closely related to the Leopard Moth. The larvæ infests locust, willow, chestnut, poplar and oak. It is reported to be a serious pest of the oak at times, so that trees are rendered unfit for any use except fire wood.

Treatment: Remove and burn all infested trees or parts of them, or use the trees as fire wood before the larvæ escape.

Caterpillars: A number of lepidopterous insects deposit their eggs upon the leaves of the oak. The larvæ are frequently so destructive that whole trees are defoliated.

Treatment: (See under ash).

The Cylindrical Basket Worm or Bag-worm. (See bag-worm under apple).

Leaf-miners. (See under apple).

Oak Bark-beetles (Scolytidæ): A large number of species of bark-beetles occur in the oak. The familiar shot-hole effect is produced as the result of the adults making their exit from the trees. Some borers work into the wood and attack both healthy and declining trees.

Treatment: Remove affected parts and burn. If the trees be declining stimulate them by such means as pruning and fertilizing.

Oak-borers: The oak is the subject of attack from several species of both flat-headed and round-headed borers. Some attack sound trees, while others prefer to limit their work to dead or decaying trees.

Treatment: Badly infested trees should have the parts attacked removed and burned. When the openings of burrows are seen, inject carbon bisulphide with a spring bottom can and close the opening with soft clay.

The Oak-miner: (See remedy for Apple Leaf Miner).

The Oak Saw-fly: (See remedy for Saw-fly of ash).

II. *Sucking Insects.*

Aphids. (See under apple).

The Oak Chermes. (See under Larch).

Oak Gall-flies: Galls are produced on plants by many species of insects belonging to several orders. Among these are gnats, aphids, mites, flies, moths and beetles. The true gall-flies, however, belong to the order which includes the bees and wasps (Hymenoptera). These produce galls so characteristic of the species that the gall serves to identify the insects which made it. After the egg is deposited by the female insect, the plant tissue is so effected that it grows to form the gall. Thus, the maggot-like larvæ lives within and develops in the small central cavity. The adult makes its exit when mature.

Treatment: Generally, the galls seem to produce no ill effects on oak trees and require no attention. If, however, they appear to be detrimental to the tree they should be gathered and burned before the adults make their escape.

The Golden Oak Scale (Asterolecanium quercicola Bouche.): (Same remedies as for Lecanium on apricot).

III. *Plant Diseases.*

Anthracnose. (See under sycamore).

Decay or Brown Rot. (See under ash).

Heart Rot. (See under beech).

Root Rot. (See under cherry).

White Rot. (See under ash).

PEACH.

I. *Chewing Insects.*

Grasshoppers (Acridiidae): These common pests often devour foliage of trees, especially when much grass grows near them.

Treatment: Spray with an ounce of arsenate of lead in each gallon of water, or poison with sweet bran mash or criddle mixture.

The Peach-tree Borer. (See under apricot).

The Plum Curculio. (See under apple).

Shot-hole Borers: As a rule, only sickly or declining trees are attacked. The work of these insects is described under Scolytid bark-beetles of the apple, which see.

The Bud Moth (Spilonota ocellana Schiff.): The larvæ of this moth are small, brown caterpillars with black heads, and are found in spring attacking and devouring tender buds and blossoms. Later they web the leaves together and feed within the cluster.

Treatment: Spray with arsenate of lead (27 a), or Paris green (26 a), immediately after the leaf buds open.

II. *Sucking Insects.*

The Lecanium Scale. (See under apricot).

The Black Peach-aphid (Aphis persicæ-niger E. F. Smith): This plant louse is a shining black insect which lives on the leaves, twigs, and roots of the peach. The root-infesting insects are particularly destructive, and cause the tree to be very much weakened so that in severe cases the leaves are drooping and yellow.

Treatment: The root-infesting forms can be controlled by exposing the infested roots, and applying a quantity of tobacco decoction (41 a), or ground tobacco leaf, or stems (41 b), or kerosene emulsion (32 a). Spray the trees with whale-oil soap solution (33 b).

The San José Scale. (See under apple).

III. *Plant Diseases.*

Brown Rot, Ripe Rot, or Monilia Rot [Sclerotinia fructigena (Pers.) Schroet]: This is the common Brown Rot, or Ripe Rot of the stone fruits,—peach, plum, nectarine, cherry, and apricot. It first appears as a small brown, decayed spot, which spreads until the whole fruit is involved and becomes covered with gray dust (Spores or Rot germs). By evaporation of the water, the diseased fruit dies and shrivels, and is then said to be "mummified." These fruit may remain on the tree or fall to the ground. Under either condition they are the source of infection the following year. Twigs are also attacked and blighted by this disease, which causes brown spots in the bark of young peach twigs.

Treatment: Gather and destroy all mummified fruits. If possible remove the growing fruit as it becomes diseased. Prune trees to admit sunshine, and thin the fruit. Spray with Bordeaux mixture (41 a), or lime-sulphur solution (34 dilute) during the dormant season. Spray with weak Bordeaux (42 b), or (better) self-boiled lime-sulphur solution (35), when the fruit is one-third grown and again two weeks later. The last named (Scott's formula) self-boiled lime-sulphur as a summer spray, is the most important step in preventing Brown Rot.

Crown Gall. (See under apple).

Leaf Curl. During wet springs a certain fungus attacks peach leaves causing the leaves to thicken, crumple, turn white, and later, pink, red, and brown, and the deformed leaves finally drop. This defoliation also causes the fruit to drop or to be inferior.

Treatment: Spray with Bordeaux mixture (42 a), or lime-sulphur solution (34), as for San José Scale, before the leaves appear in spring.

Scab. (See under apricot).

Yellows, Rosette, and Little Peach: These three diseases of the peach are believed to be closely allied. (a) In the case of *Little Peach*, the fruit does not attain more than half size, and the flesh is insipid and bitter, and does not ripen on time, while the leaves are undersize, closely set on the twigs, and yellow or reddish in color. (b) *Peach Rosette* may be known by the tufts or rosettes formed by the growing shoots, which do not lengthen but become bunchy, so that the leaves are formed close together. (c) *Peach Yellows* is first recognized with certainty by the premature ripening and internal red spotting of some fruits, with red interior streaks. Later the leaves become yellow, slightly rolled, and set at right angles to the twigs; next appears a growth of bunchy twigs and leaves from the large limbs, soon followed by the death of the tree.

Treatment: Cut out infected trees and burn them as soon as the first signs of the disease are recognized. Be careful to avoid bringing diseased trees in contact with healthy ones.

Powdery Mildew [*Sphaerotheca pannosa* (Wallr.) Lév.]: This fungus attacks many plants, including the peach, cherry, apple and quince. It makes its appearance about mid-summer on the leaves and young twigs, as small white blotches. These spots enlarge and cover the surface of the leaf. The powdery appearance is caused by the numerous, minute, white, summer spores, which are blown about by the wind or carried by other agencies to unaffected leaves.

Treatment: Inasmuch as the winter spores remain on the fallen leaves, there to become active again in the spring, the possibilities of such infection will be greatly lessened by burning these leaves. Spray with Bordeaux mixture (42 a), or ammoniacal copper carbonate (43) as soon as the leaves are well formed, and at intervals of ten days or two weeks thereafter, until mid-summer.

PEAR.

I. *Chewing Insects.*

The Codling Moth: (See under apple).

Curculio: (See under apple).

The Fall Web-worm: (See under apple).

The Pear Slug: (See Leaf Slug under cherry).

Borers: (See under apple).

II. *Sucking Insects.*

The Oyster Shell Scale. (See under apple).

The Pear Psylla: (See under apple).

The San José Scale. (See under apple).

The Scurfy Scale: (See under apple).

III. *Plant Diseases.*

Brown Rot or Decay: (See under ash).

Crown Gall: (See under apple).

Leaf Blight (*Entomosporium maculatum* Lév.): This bacterial disease makes its appearance soon after the leaves develop. Dull reddish spots are formed on the upper surface of the leaves; but as the disease spreads, dark brown spots appear on the under surface also. Thus, the entire leaf may be involved, when it turns yellow and drops. The limbs and fruit are also attacked. The former become blackened, while the latter is covered with reddish spots, which cause the rind to become rough and to crack open.

Treatment: As for Apple Scab.

Pear Blight or Fire Blight. (See under apple).

Rust. (See under apple).

Scab. (See under apple).

PINE.

I. *Chewing Insects.*

Pine Bark Beetles. (See Scolytid Bark-beetles of Apple).

Pine Borers of "Sawyers". (See Borers of Apple).

Pine Caterpillars. (See under ash).

Pine Leaf-miner (Paraleckia pinifoliella Cham.): Frequently one sees pine needles, the end of which present a dead and brown appearance. This is caused by the work of the Pine Leaf-miner, which, as its name suggests, has eaten the interior of the needle. The larvæ is that of a small moth.

Treatment: Cut off and burn infested "tassels" of needles.

The Pine Saw-fly (Lophyrus abbottii Leach): Closely allied to the fir saw-fly, which see.

Pine Timber Beetles: The boring larvæ of several species of beetles infest sound and healthy pine; while others live in down or decaying timber.

Treatment: Burn all infested timber not available for use. Burn all old bark and brush. Useful timber should be promptly manufactured into lumber. Practice such methods as will tend to utilize timber promptly. For shade trees, not too badly infested with borers, success may be had in checking the ravage of the borers by following methods recommended for borers of the apple (which see). Preserve the birds, especially the Woodpeckers, as these are the chief enemies of borers.

Pitch Pine Twig Tortrix or Retinia (Retinia comstockiana Fern): This is a moth whose larvæ infests the small branches of the pitch pine. The caterpillar is yellowish brown in color. It bores through the center of the twig, thus causing resin to exude through the wound and harden on the exterior of the branch. The adult emerges in May or June.

Treatment: Remove and burn infested branches.

The White Pine Weevil (Pissodes strobi Peck.): This weevil causes abnormal branching of twigs of white pine trees as the result of successive attacks on the terminals of young trees.

Treatment: Remove and burn infested branches as soon as noticed.

II. Sucking Insects.

The Pine-inhabiting Aphis: Spray with one pound of whale-oil soap in six gallons of water, wherever the pests are present.

The Pine Chermes: (Chermaphis pinicorticis Fitch.): When young, apply the remedy mentioned above for Aphids.

The Pine-leaf Scale (Chionaspis pinifoliae Fitch.): This scale causes the needles to be stunted and short. It is conspicuous as its white color stands out on the the green back ground of the leaves.

Treatment: Same as for San José Scale (under apple).

III. Plant Diseases.

Dry Rot. (See under hemlock).

PLUM.

I. *Chewing Insects.*

The Peach Tree Borer. (See under apricot).

The Plum Curculio. (See under apple).

Shot-hole Borers: (See under Scolytid Bark-beetles of Apple).

II. *Sucking Insects.*

The Lecanium Scale. (See under apricot).

The Peach Aphid: (See under Peach).

The San José Scale: (See under apple).

III. *Plant Diseases.*

Black Knot. (See under cherry).

Brown Rot. (See under peach).

Crown Gall. (See under apple).

Leaf Spot. (See under cherry).

Plum Pockets (Exoascus Pruni Fuckel.): The disease of plums known as Plum Pockets, makes its appearance soon after the flowers have fallen. The "Pockets" are rather globular in shape at first, and much resemble the unaffected fruit, but are yellow to red in color. As the season advances they lengthen, and become wrinkled and gray and finally brown or black. About the last of June these mummied fruits fall to the ground.

Treatment: All infected branches should be pruned about eight inches from the tip. Remove the pockets before they mature. Burn the removed pockets and twigs.

Root Rot: (See under cherry).

Scab: (See under apricot).

Yellows: (See under peach).

POPLAR.

I. *Chewing Insects.*

Borers: The Poplar is the subject of attack of borers of several species. One is the larvæ or grub, of a beetle (*Saperda calcarata* Say), while two others are the caterpillars of *clear-winged moths* (*Sesiidæ*). Their depredations are often so serious as to ruin infested trees.

Treatment: (See Borers under apple).

Caterpillars: (See under ash).

Leaf-miners: (See under apple).

The Leopard Moth: (See under Linden).

II. *Sucking Insects.*

The Poplar Aphis (Pemphigus sp.): Several species of aphids are found on poplar trees. Their habits are similar to those of the Apple Aphis, which see.

The Poplar Gall-louse (Pemphigus populivenæ Fitch): One species of aphis or plant louse causes galls to form on the veins of poplar leaves. These galls are nearly one-half inch in diameter and almost spherical. In the beginning a single plant louse inhabits the gall, but if the gall be cut open in mid-summer, it will be found to contain many aphids—the progeny of the original inhabitant.

Treatment: If the galls are detrimental to the tree, the infested leaves should be gathered and burned. Burn all kinds of gall-infested leaves as soon as they fall.

The Oyster Shell Scale. (See under apple).

III. *Plant Diseases.*

Decay or Brown Rot: (See under ash).

Heart Rot: (See under beech).

PRIVET.

I. *Chewing Insects.*

White Grubs (Lachnosterna sp.). The larvæ of June “bugs,” or May beetles, commonly known as “white grubs,” or “grub worms,” are frequently destructive to the roots of plants.

Treatment: In the case of infested privet make holes about two feet apart along the hedge, pour in one-fourth cup of carbon bisulphide, and close the holes with clay.

III. *Plant Diseases.*

Anthraxnose: (Glæosporum cingulatum Atkinson): The anthracnose, of privet attacks tender twigs in which small dark spots develop. These spread so as to girdle the twig and kill it.

Treatment: Remove infected twigs several inches back from the diseased portion and burn.

QUINCE.

I. *Chewing Insects.*

Borers. (See under apple).

The Codling Moth: (See under apple).

Curculios: (See under apple).

The Pear Slug: (See leaf slug under cherry).

II. *Sucking Insects.*

The San José Scale: (See under apple).

III. *Plant Diseases.*

Bitter Rot: (See under apple).

Black Rot: (See under apple).

Leaf Blight: (See under pear).

Pear Blight or Fire Blight: (See under apple).

RHODODENDRON.

III. *Plant Diseases.*

Rust [*Chrysomyxa Rhododendri* (De C.) De Bary]: Just as the apple rust requires two hosts,—commonly the apple and cedar,—so does the rhododendron rust. It is parasitic on the rhododendron and spruce, or fir; so that if both plants be in close proximity the rust thrives.

Treatment: The only known reliable method of combating this disease is to destroy either one of its hosts.

ROSE.

I. *Chewing Insects.*

The Rose Beetle (*Aramigus fulleri* Horn.): The Rose Beetle is a snout-beetle, about one-half inch long. The larvæ feed on the roots of rose plants, while the adults subsist on the leaves, flowers and buds. The latter feed at night and hide during the day on the under side of the leaves.

Treatment: Pour tobacco decoction (41 a) on the ground to destroy larvæ. The adults can be controlled by gathering and destroying them, or jarring, as for curculio of plum.

The Rose Chafer or Rose "Bug" (*Macrodactylus subspinosus* Fab.): The well known Rose Bug is a slender beetle, about three-eighths of an inch long. It is yellowish-brown in color, while the legs are red. The insect attacks a wide variety of trees and ornamental shrubs.

Treatment: Pick by hand, or shake into a pan partly filled with water and covered with a film of kerosene. Place cloths soaked in oil under infested plants, and shake the insects on the cloth. Protect plants with mosquito netting or enclose fruits in paper bags. Spray with lead arsenate (27 a).

The Rose Slug (Endelomyia æthiops Fab): The common Rose Slug is the larvæ of a saw-fly. The larva is greenish above and yellow below. They feed on the upper surface of the leaves. Two broods occur in a year,—one in June and one in August.

Treatment: This is one of the simplest pests to control. A simple remedy is to dust the leaves with a mixture of Paris green (1 part) in air-slaked lime (50 parts). They may also be killed by spraying with lead arsenate (27 a), or Paris green (26 a), or with contact insecticides such as whale-oil soap solution (33 b), or dusting with dry freshly slaked lime.

The Rose-leaf Roller (Archips rosaceana Harr): This is the larva of a moth, and as its name suggests, causes the rolling or curling of the leaves. It is often troublesome in orchards, on roses, and on small fruits.

Treatment: Destroy by hand picking, or spray with lead arsenate (27 a), or Paris green (26 a).

The Rose Leaf-cutter (Megachile sp.): A bee which cuts round holes in rose leaves, controlled by arsenical spray (27 a).

II. Sucking Insects.

The Rose Aphis (Nectarophora rosæ Linn.): Plant lice are often serious pests on roses, infesting the shoots, buds and under sides of leaves.

Treatment: Spray with tobacco decoction (41 a), whale-oil soap solution (33 b), common laundry soap solution (33 a), kerosene emulsion (32 a), or dust plants with tobacco dust, when damp or after sprinkling them with water.

The Rose Scale (Aulacaspis rosæ Bouche): This scale insect, which is common on rose and raspberry bushes, is pure white, nearly one-eighth of an inch in diameter and hence is conspicuous. It is a more serious pest on plants in shady situations.

Treatment Spray at any time with kerosene emulsion (32 a), whale-oil soap solution (33b), or common laundry soap solution (33 a); or spray when dormant with strong lime-sulphur solution, as for San José Scale of apple.

The San José Scale: (See under apple).

Leaf-Hoppers: (See under apple).

III. Plant Diseases.

Crown Gall: (See under apple).

Rose Leaf Blotch or Spot [Actinonema Rosæ (Lib.) Fr.]: The Rose Leaf Blotch is characterized by the development of irregular brown spots on the upper side of the leaves. Sometimes a large spot may involve half the leaf.

Treatment: Spray with Bordeaux mixture (42 b) at least one month in advance of the blossoming period; or with potassium sulphide (44); or ammoniacal copper carbonate (43).

Powdery Mildew: (See under peach).

IV. Other Enemies.

Red Spider or Mite (Acarina): The Red Mite is often a serious pest of roses and many other plants. It is a very small red and whitish creature, which spins a fine web on the under side of a leaf, and sucks the plant juices. Badly infested leaves become yellow and drop.

Treatment: Spray with tobacco decoction (41 a), or kerosene emulsion (32 b), or whale-oil soap solution (33 b), or potassium cyanide, or dilute lime-sulphur, or apply sulphur dust, or tobacco dust after the plants have been sprinkled with water.

SPRUCE.

I. Chewing Insects.

Bark Beetles: (See under Scolytid bark beetles of apple).

Caterpillars: (See under ash).

Spruce Borers: The borers, which infest the spruce are closely allied to those found in pine, which see.

III. Plant Diseases.

Decay or Brown Rot: (See under ash).

Dry Rot: (See under hemlock).

Root Rot: (See under cherry).

Rust: (See under cedar and apple).

SYCAMORE or PLANE TREE.

I. Chewing Insects.

The Sycamore Leaf Folder: (See Leaf-folder of rose).

III. Plant Diseases.

Anthracnose [*Gnomonia Veneta* (Sacc. & Speg.) Kleb.]: This is a most detrimental disease at times to the sycamore. It attacks leaves, shoots, seedlings and young trees, making the leaves turn brown in summer.

Treatment: Spray thoroughly and early with Bordeaux mixture (42 a).

WALNUT.

I. *Chewing Insects.*

Caterpillars: (See under ash).

The Walnut Curculio: This is a Snout Beetle, such as is discussed under "Chestnut".

II. *Sucking Insects.*

The Walnut Scale: Closely allied to the San José Scale, which see under apple.

The Oyster Shell Scale: (See under apple).

III. *Plant Diseases.*

Crown Gall: (See under apple).

Decay: (See under ash).

WILLOW.

I. *Chewing Insects.*

Borers: (See under apple).

Caterpillars: (See under ash).

The Snowy Tree Cricket: (See under apple).

Willow Leaf Miner: (See under apple).

Willow Saw-fly (*Cimbex americana* Leach): This insect produces egg-blisters on leaves of the willow and causes further injury by girdling the twigs.

Treatment: See under ash).

II. *Sucking Insects.*

The Oyster Shell Scale: (See under apple).

The San José Scale: (See under apple).

The Willow Aphid: (See under apple).

III. *Plant Diseases.*

Black Spot [*Rhytisma Salicinum* (Pers.) Fr.]: This malady of the willow is closely allied to the Leaf Blotch, or Black Spot that infects the Maples, which see.

Crown Gall: (See under apple).

Decay: (See under ash).

White Rot: (See under ash).

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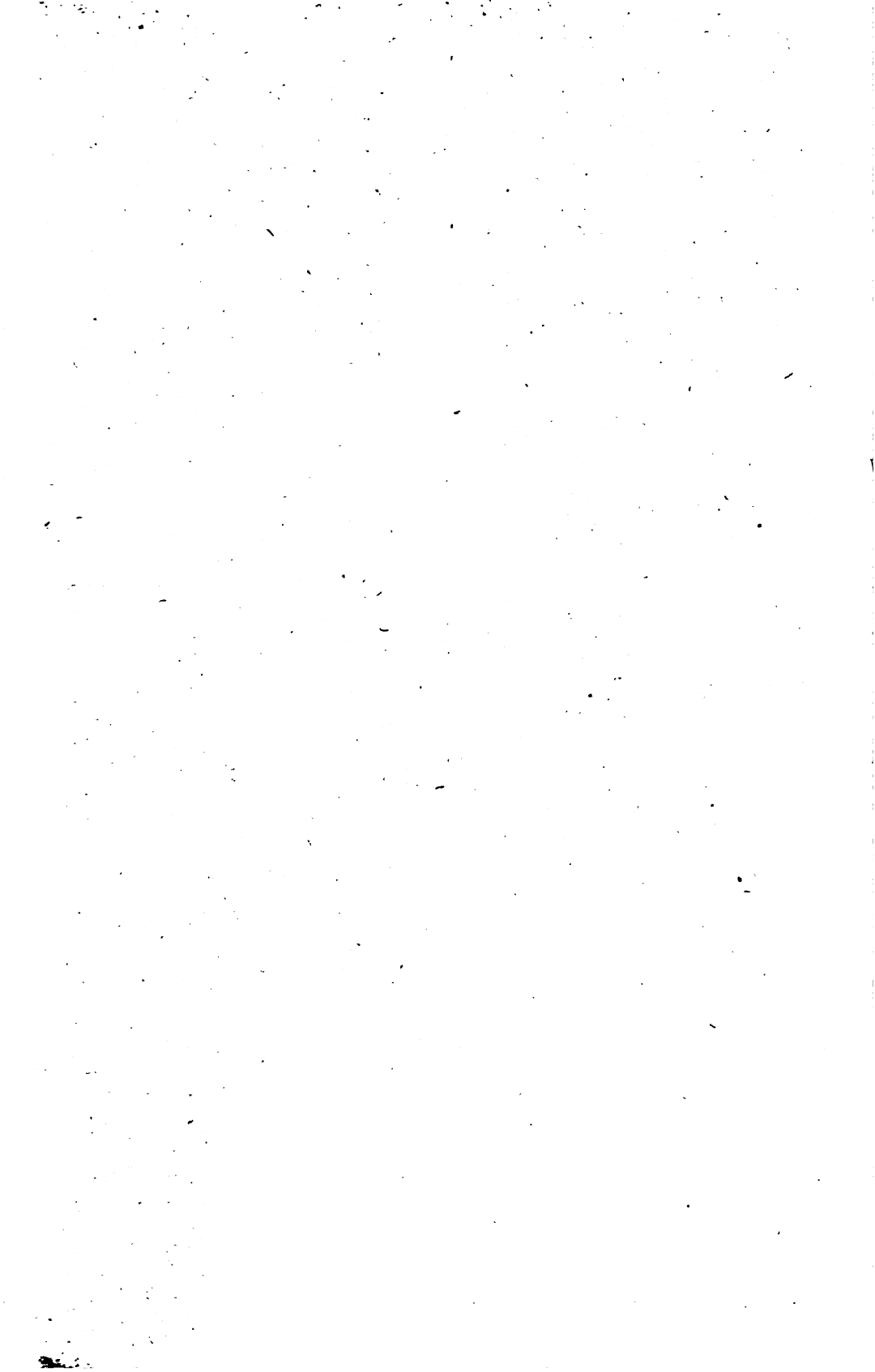
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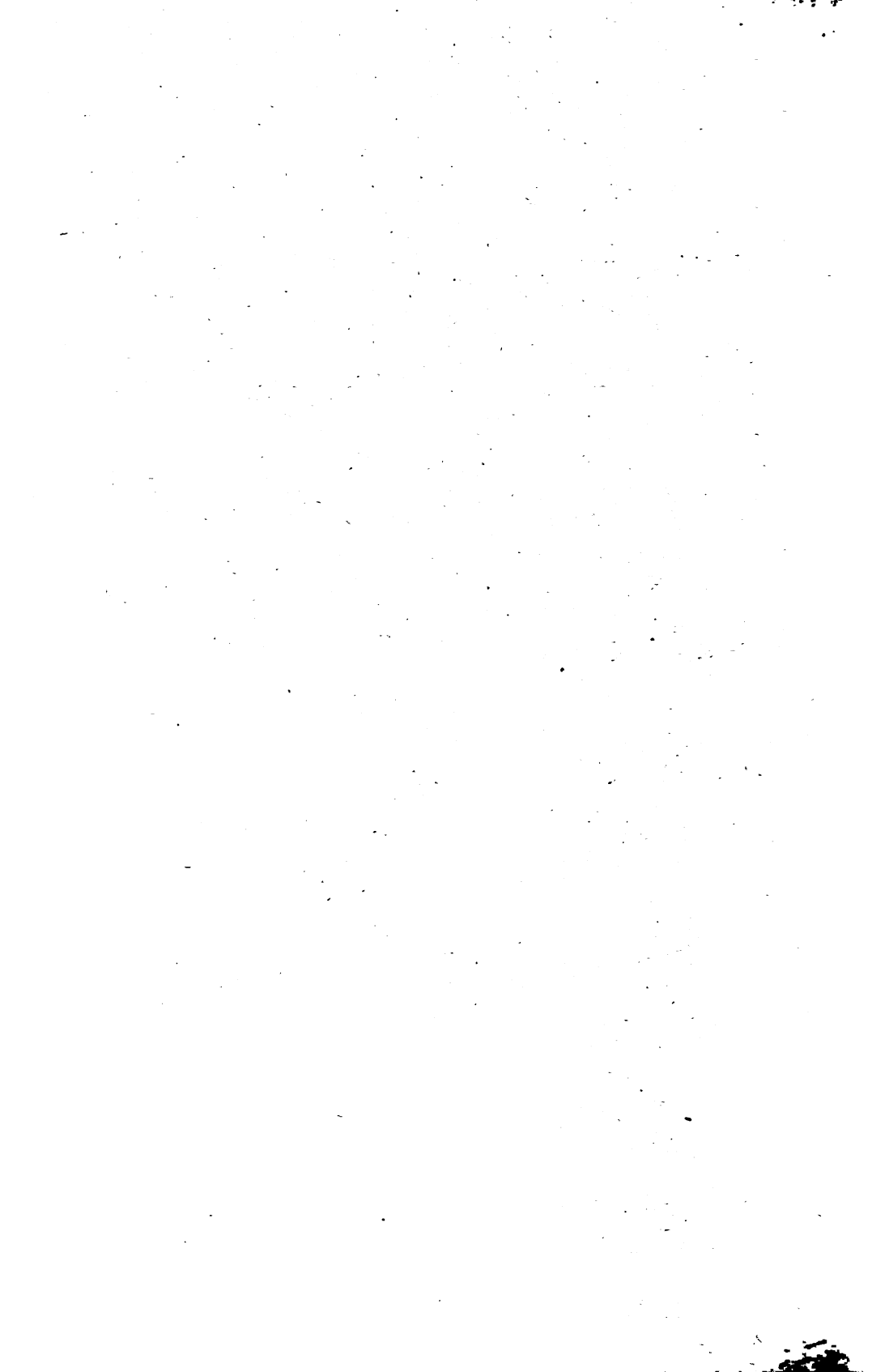
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THE BI-MONTHLY
ZOOLOGICAL BULLETIN



OF THE

DIVISION OF ZOOLOGY

OF THE

PENNSYLVANIA DEPARTMENT OF AGRICULTURE

VOL. III.—No. 1.

SUBJECT: { PESTS OF DOMESTIC ANIMALS,
HOUSEHOLDS AND BUILDINGS,
BUSH FRUITS AND LAWN PLANTS.

JANUARY, 1913.

H. A. SURFACE, D. Sci., Economic Zoologist,
Editor.

Entered as Second-Class Matter, January 13, 1911, at the Post Office at Harrisburg, Pa., under the Act of June 6, 1910.

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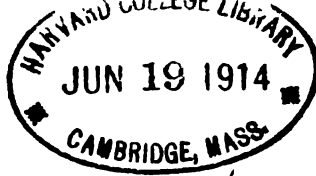
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Commonwealth of Pennsylvania

THE BI-MONTHLY ZOOLOGICAL BULLETIN OF THE DIVISION OF ZOOLOGY FOR JANUARY, 1913.

VOL. III. NO. 1.

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PREFACE

This number is the tenth volume of periodical bulletins issued by the Division of Zoology, Department of Agriculture. The first seven volumes were issued as Monthly Bulletins with twelve numbers in each volume. They discussed various subjects in regard to zoology, pest suppression, orchard management, insect study, bird preservation, serpents, lizards, turtles, and kindred topics. Some of these yet remain in this office available for those who request them. Many others are entirely out of print and unavailable. We also published during 1903 and 1904 a series of Bulletins on birds, called "The Zoological Quarterly Bulletin," which ended with No. 1, Volume III, May, 1905. None of these are now available.

The Monthly Bulletin ended with Volume VII, No. 12, May, 1910. In its place the Bi-Monthly Bulletin was established, commencing with Volume 1, No. 1, January, 1911. This is practically only a new series like the Monthly Bulletins, published bi-monthly. In this series we have especially discussed topics of pest suppression, spraying, pruning, orchard management, the inspection and orchard demonstration work of this office, bees, birds and kindred subjects.

In the combined issue for July and September, 1912, Volume II, Nos. 4 and 5, we commenced the publication of a series of Bulletins on "Pests and Their Suppression." That Bulletin gave a full set of formulae and should be kept for reference. The subject of "Pests of the Field, Garden and Truck Crops," was discussed in the same Bulletin. In the November Number, which was Volume II, No. 6, was published a full discussion of "Pests of Trees," including fruit trees, shade and forest trees, with an index to the numbers included in Volume II, for 1912.

This issue, Volume III, No. 1, for January, 1913, concludes the three bulletins of the series on Pest Suppression, and should be used in connection with the last two numbers of the previous volume. Formulae herein referred to are given in full in the issue for July and September, 1912. Copies of these bulletins are yet available in this office, and may be obtained upon application.

As reference is made to these bulletins and their contents in our correspondence, it is important to know if persons making inquiries by letter are receiving the bulletins. We, of course, can learn this by taking considerable time to look through the mailing list of 30,000 names, but if correspondents would mention the fact that they have

received and preserved their bulletins, we could save considerable time and work by referring them at once to the respective numbers and pages where some of their inquiries are answered.

There is no plant pathologist, horticulturist, nor botanist provided by law in the Department of Agriculture, at Harrisburg. For this reason purely horticultural and botanical questions, such as the naming of fruits and plants and those on plant diseases, should be submitted respectively to professional horticulturists and botanists such as can be reached at the Pennsylvania State College, State College P. O., Centre County, Pennsylvania, or the United States Department of Agriculture, Washington, D. C.

There is room on our mailing list for more names to receive the bulletins. This list was revised in the spring of 1911 and we removed over 15,000 names that did not respond to our card of notification. We invite you to send names of friends, but please ascertain first if they are already on the list, in order to avoid duplication.

All citizens of this State are invited to make use of the services of this office. We make a special point of helping every person to find answers for his inquiries, whether they are along the line of our profession or not. It is a pleasure to live to be helpful to others, but unless we know their needs and ways in which they can be helped, it is impossible to extend full service to them.

Our correspondence is naturally heavy and increasing, but this is far more gratifying than though it were growing less, and our citizens were not making use of the opportunities afforded them by the State. Care should be taken always to give the name and address of each inquirer on a communication and especially to write the name plainly. It is remarkable what a number of our replies are returned to us because the original inquirer can not be located or letters cannot be answered because not properly signed. Wherever inquiries can be answered in full by printed matter, this is mailed and should be taken as a reply as complete as though it were written.

Specimens should be sent with inquiries when possible and so packed or wrapped that they will not be crushed in the mail. The name and address of the sender should be on or in each package.

Bulletins on special topics will be sent upon request, if available. We have no list of bulletins by topics from this office.

Address all communications to

H. A. SURFACE.
Economic Zoologist,
Harrisburg, Pa.

PESTS OF THE HONEY BEE.

I. CHEWING INSECTS.

THE BEE MOTHS (*Galleria melonella* Linn. and *Achroia grisella* Fabr.): These two species of bee-months or wax-moths occur in hives in the United States. The former species, known as the Greater Bee-moth is much the commoner. The fore wings are purplish-brown, while the hind wings are dusky. At night the female moth creeps into the hive to lay her eggs. The larvae tunnel in concealment through the combs, destroy the wax, and kill the larvae or uncap the cells. The results are the rows of "bald-headed brood" from which the cappings have been eaten away, or empty cells, from which the bees have removed the dead brood.

Treatment: Keep the hives clean and inclined slightly toward the front. Split reeds, that are hollow, like the stalk of the elder, can be put into the hives with the split side downward, to give the moths or larvae an opportunity to hide in the hollow, and should be removed twice per week to kill the pests that are thus trapped. The best remedy is a strong colony of Italian bees, as these clean up the moth better than other races; therefore, requeening with an Italian queen is best where wax worms are bad. Old combs and neglected hives should not be permitted around the apiary, as they are breeding places for bee-moths.

II. SUCKING INSECTS.

THE BEE LOUSE (*Broula caeca* Nitzsch): This peculiar parasite of the honey bee is common in Europe, whence it is sometimes imported with bees into this country. It is not common, however, in apiaries in America. It is a rather large, dark brown, wingless louse-like insect, possessing six legs, and belongs to the entomological order of Diptera or two-winged flies. The body and legs are finely hairy. It clings to the bee and causes it much annoyance.

Treatment: The Bee Louse is plainly seen by examining the bees, and can be removed with a brush, or, when the worker is found with the louse upon it, both bee and parasite should be killed and removed from the hive. In order to prevent introduction of the Bee Louse into the hive, queens from Europe should be examined when received.

III. DISEASES OF THE HONEY BEE.

AMERICAN FOUL BROOD: This disease, as well as the succeeding one, attacks bees in the larval form, causing them to die and decay or become foul. When the hive of an infected colony is opened the foul odor from the decaying brood is perceived; hence

the name "foul brood." The disease discolors the larvae causing them to become brown and finally black. Infection generally takes place when the cells are capped. Such caps become sunken and perforated. This disease is best characterized by the fact that when a stick is inserted into a victim of the disease and carefully withdrawn the decaying ropy mass adheres to the stick and may stretch out for several inches without breaking off. Generally only worker larvae are attacked.

Treatment: As the diseases of bees are carried only in infected honey, they can be readily eradicated in a colony if one uses good judgment and proceeds carefully and properly. The most reliable remedy is to shake the bees of the infected colony into a clean hive on clean frames that are provided only with starter strips of comb foundation. Then render the old combs into wax and destroy all the old honey. This is best done in the evening and when there is a good honey-flow. The combs of the infected hive should be destroyed or melted at once, and the greatest care should be taken to avoid letting any of the infected honey fall on or in any part of the new hive, or on the ground, and to prevent any other bees from getting any of this infected honey. A single drop of infected honey carried into a hive by a bee will give the disease to the colony.

EUROPEAN FOUL BROOD: Unlike the preceding disease, European foul brood attacks the larvae at a much earlier time in their development, the infection generally taking place before many cells are capped. The odor, too, is more like that of soured dead brood, and the "stick-test" shows none of the ropiness or stringiness, characteristic of American foul brood. Then, too, the infection in the present instance takes place more rapidly and readily.

Treatment: As for "American foul brood."

IV. OTHER ENEMIES.

THE KINGBIRD OR BEE MARTIN (*Tyrannus tyrannus* Linn.): While this is too popularly supposed to be a great enemy of bees, it is really more a destroyer of those insects, like the Robber-fly, which kill honey bees, than it is of the bees themselves. Analyses of the stomach contents show that the Kingbird feeds mostly upon drones, and is not a serious enemy of the worker.

TOADS (*Bufo lentiginosus* Shaw.) and **SERPENTS** (*Ophidia*): Toads and serpents sometimes eat bees, but they are so beneficial for the destruction of other insects that they can be tolerated without complaint. Take them away from the bee yard and keep them busy in the garden and other parts of the premises, or set the hives on stands.

MICE (*Mus musculus* Linn.) Among the worst enemies of bees are mice that enter the hive, especially during winter, and destroy bees and comb. The entrance to the hive should be small enough to prevent their getting in, or it should be covered with wire netting of three meshes to the inch, which will let the bees pass but keep out the mice.

(For further discussion of Bees, see the "Bee Bulletin," Bi-monthly Bulletin, Division of Zoology, Vol. II., No. 3. Sent free upon request.)

PESTS OF STORED GRAIN AND HAY.

I. CHEWING INSECTS.

THE ANGOUMOIS GRAIN MOTH (*Sitotraga cerealella* Oliv.): The adult moth is a very small, light grayish-brown "miller," more or less spotted with black, with a wing expanse of about half an inch. The eggs are deposited sometimes upon the heads of grain in the field, and later in stacks and mows and in stored grain. They attack all the cereals, but are especially injurious to wheat. The larvae hatch and enter the grains, three or four larvae in one grain in the case of corn, and feed upon the interior. They continue breeding in the mow and bin until cold weather sets in. Infested kernels are left as mere hulls.

Treatment: Thresh grain immediately after harvest. The bins in the granary should be thoroughly swept and brushed before new grain is stored in them. Fumigate with carbon bisulphide (37),* placing the liquid in a shallow vessel in a depression in the top of the bin of stored grain, and cover the bin with a damp blanket to prevent the escape of the fumes. The gas which forms by evaporation is poisonous, and also explosive if ignited. Keep fire away.

THE CLOVER-HAY WORM (*Hypsopygia costalis* Fabr.): The adult insect is a moth with golden-banded wings which expand about four-fifths of an inch. The caterpillars feed upon clover-hay stored in stacks or mows and, by weaving extensive webs and leaving the black excrement, destroy more hay than is eaten.

Treatment: Cleanliness is the first requisite in controlling and eradicating this pest. Before clover-hay is put into the barn, see that the mow is thoroughly swept to remove all old hay and refuse. Do not build clover-hay stacks on old foundations, as the latter are apt to be infested.

THE GRAIN WEEVIL (*Calandra granaria* Linn.): This insect possesses a short, stout beak and belongs to the Calandridae, whose members are known as the "Bill-bugs." In the case of the true Weevil the beak is long and slender. The grain weevils infest stored grain of all kinds. The adult is a dark red beetle which deposits

*Numbers here given refer to formula given in the July and September Bi-monthly Bulletin, 1912.

its eggs upon the grain. These soon hatch, and the resulting larvae, which are legless, devour the interior of the kernels. Several broods appear in a season.

Treatment: Practice cleanliness. Clean bins well. Fumigate with carbon bisulphide (37) or hydrocyanic acid gas (38). Fumigate or boil old infected bags before using.

THE RICE WEEVIL (*Calandra oryzae* Linn.): The rice weevil is closely related to the preceding species. In color it varies from chestnut brown to black, and in length measures but one-fifth of an inch. The habits are similar to those of the grain weevil.

Treatment: As given for the "grain weevil."

THE MEDITERRANEAN FLOUR MOTH (*Ephestia kuehniella* Zell.): This is a grayish moth whose wing expanse is about one inch. It infests granaries and flour mills. In the latter it becomes very troublesome. Indeed, webs from the larvae of this moth often become so numerous as to clog the milling machinery.

Treatment: As for the "grain weevil." We have cleaned up large mills by fumigating with hydrocyanic acid gas. (See Monthly Bulletin, August, 1905, of the Bureau of Zoology, Harrisburg, on "Mill Pests.")

Note.—For discussion and treatment of other grain pests see "Pests of the Household."

THE GRAIN BEETLES: Two species of beetles attack stored grain. To this they do not limit their efforts, however, but are omnivorous. The insects are known as the *Saw-tooth Grain Beetle* and the *Cadelle*.

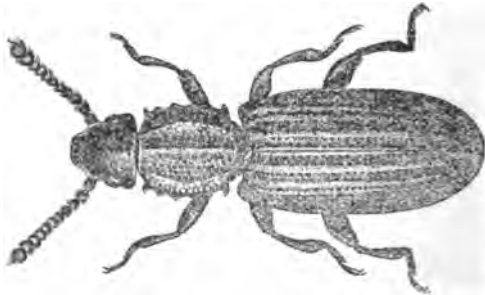


Fig. 1.—*Silvanus surinamensis*, the saw-toothed grain beetle.

THE SAW-TOOTH GRAIN BEETLE (*Silvanus surinamensis* Linn.): This insect is called the Saw-tooth Grain Beetle because the edge of the thorax bears six spines and has a fancied resemblance to a saw. The insect measures scarcely one eighth inch in length and is of a brown color. The larva is flattened and nearly white, with dark markings. This species is particularly fond of cereals, bread stuffs, nuts, seeds, and preserved fruits.

Treatment: As for "meal moths."

THE CADELLE (*Tenebroides mauritanicus* Linn.): The Cadelle is more conspicuous than the preceding because of its larger size. Adults average three-eighth inch in length. This insect is found in nuts and cereals, but may infest any food that contains starch.

Treatment: As for "meal moths."

BUSH FRUITS: BLACKBERRY.

I. CHEWING INSECTS.

THE BLACKBERRY-GALL MAKERS (*Diastrophus nebulosus* O. S., and *D. cuscutoæformis* Harr.): These two species of gallmakers cause the development of irregular, warty swellings on the stems of blackberry. The galls are inhabited by a number of larvae, which feed upon the tissue of the galls, and in which they pupate, later emerging as small, mature, wasp-like insects.

Treatment: Cut out and burn infested canes wherever the knots or galls are seen.

THE RASPBERRY CANE-BORER (*Oberea bimaculata* Oliv.): This is a slender, black beetle with a yellow pro-thorax, and about one-half inch in length. The eggs are deposited in June on the canes of raspberry and blackberry, between two circular rows of punctures about one half inch apart. This injury causes the tips of the canes to wither. The larvæ soon hatch and bore downward through the pithy center of the cane.

Treatment: Cut and burn infested parts of canes as soon as the borers are found. Spray the leaves in spring with arseuate of lead (27 a) or Paris green (26 a).

THE RASPBERRY SAW-FLY (*Monophadnoides rubi* Harr.): The larvae of the raspberry saw-fly are small, slug-like creatures which appear about the latter part of June and often devour the foliage to such an extent as to injure the raspberry and blackberry bushes severely.

Treatment: Spray with lead arsenate (27 a) or Paris green (26a) as soon as pests appear and repeat in a few days if all are not killed.

THE RASPBERRY FRUIT WORM (*Byturus unicolor* Say.): This is the larvae of a small yellowish, elliptical beetle whose body is densely covered with hairs and measures about one-fourth inch in length. The adult feeds on the flowers where it deposits its eggs. The white naked larvae live in the berries.

Treatment: If sufficiently numerous to be injurious spray the plants, just as the petals fall, with lead arsenate (27 a) or Paris green (26a).

THE SNOWY TREE-CRICKET (*Ecanthus niveus* De G.): The snowy tree-cricket, a light greenish insect with flat, white wings, is predaceous and feeds upon plant-lice and other injurious insects. However, it causes injury to raspberry, blackberry and other woody plants by making rows of punctures in the canes or young twigs to deposit its eggs.

Treatment: Cut out and burn infested parts of canes.

II. SUCKING INSECTS.

THE ROSE SCALE (*Aulacaspis rosae* Bouche): This insect is a circular white scale, measuring about one-eighth inch in diameter; it is therefore conspicuous. It is the one found commonly on the rose, but it often occurs in destructive numbers on raspberry and blackberry plants.

Treatment: As for San Jose Scale, which see under "currant."

III. DISEASES OF BLACKBERRY.

ANTHRACNOSE OR "SUN SCALD" (*Glocosporium Venetum* Speg.): This fungous disease causes light purplish spots on the young shoots when about a foot high, which spread and turn grayish white as the season advances. Finally the canes become girdled and die shortly before the ripening of the fruits, which, together with the leaves, (dry upon the canes as if scalded, hence the erroneous name of "sun scald.")

Treatment: Cut out and burn infected cane. Spray with Bordeaux mixture (42a) before the leaves open, and repeat as soon as the young canes appear, avoiding the foliage on the old canes as much as possible. Repeat in ten days or two weeks, and again before the blossoms appear. Cut and burn old canes soon after the fruit is gathered.

CROWN GALL (*Pseudomonas tumefaciens* Erw. Smith & Townsend): This disease is similar to the crown gall of peach trees. It develops as soft, corky, or spongy tissue and knots on the roots, just beneath the ground. Affected canes do not grow large, become sickly, and break off easily.

Treatment: Select only clean nursery stock. Dig out and burn diseased plants. Avoid planting in infected ground.

ORANGE RUST (*Gymnoconia Peckiana* (Howe) Tranz.): This is a conspicuous and well known disease of the blackberry and raspberry, which appears almost with the leaves. The first indication is the appearance of numerous bright orange spots which, as the season advances become rusty red in color. Infected plants are not productive and are eventually killed. They never recover.

Treatment: Cut out and burn infected plants as soon as seen. Plant resistant varieties. Destroy wild raspberry and blackberry plants in the vicinity of the berry patch. Always destroy the entire plant (by burning) when infected with rust.

CURRENT.

I. CHEWING INSECTS.

THE CURRENT BORER (*Sesia Tipuliformis* Linn.): The adult of this insect is a bluish-black Clear-wing moth of wasp-like appearance. which deposits its eggs in summer upon the stems near the buds. The white larvæ bore into the pith of the canes, causing them to become yellow and die.

Treatment: Cut out and burn infected canes as soon as seen.

THE CURRENT WORM (*Pteronius ribesi* Scop.): The currant worm is the larvae of a sawfly and is undoubtedly one of the most conspicuous members of the family of insects to which it belongs, as it attacks currants and gooseberries wherever grown. The larva is green with black dots, and when mature is nearly an inch in length. The white eggs are deposited on the veins of the under surface of the leaves. These hatch in about ten days, and the larvae feed upon the leaves,—often defoliating the plant.

Treatment: Dust with hellebore and flour (31 a) or spray with hellebore and water. Spray with arsenate of lead (27 a) or Paris green (26 a) as soon as the worms appear. If the fruit has set use hellebore (31 a or 31 b).

II. SUCKING INSECTS.

THE CURRENT APHIS (*Myzus ribis* Linn.): These plant lice attack the leaves of currant bushes, where they cause blister-like elevations of a brownish red color, which are often mistaken for a fungus.

Treatment: Spray with lime-sulphur solution immediately before the buds burst. Spray with soap solution (33 a or 31 b), or tobacco decoction (41 a) when the pests first appear. If infested leaves have become distorted they must be picked off and burned.

LEAF HOPPERS (*Jassidae*): The Leaf-hoppers, which attack a wide variety of plants, are frequently injurious to the currant and gooseberry. They insert the tiny beak into the under side of the leaf, suck out the juices, and thus cause white or gray spots on the upper side of the leaves.

Treatment: Spray infested bushes with a solution of pyrethrum (40 a); or dust with pyrethrum powder (40 c), or with finely ground tobacco (41 b), or spray with fish-oil soap solution (31 b).

THE FOUR-LINED LEAF-BUG (*Pæcilocapsus lineatus* Fab.): This insect is a yellow bug with black markings, and is about five-sixteenth of an inch in length. The adults appear about the middle of May. Although so small as to escape attention, their work becomes evident on the terminal leaves, which become covered with small semi-transparent spots. These are areas from which the insect has sucked the sap. When the succulent young leaves have been destroyed the insects attack the older leaves.

Treatment: As for the Leaf-hopper.

SAN JOSE SCALE (*Aspidiotus perniciosus* Comst.): This insect which is so destructive to the large fruits and to many species of shrubbery, is very destructive to the currant.

Treatment: Prune back the canes and spray with lime-sulphur solution during the dormant period.

THE SCURFY SCALE (*Chionaspis furfurus* Fitch.): This insect, as its name implies, is white or scurfy, and is thus conspicuous on infested trees. The young are produced from purple eggs. Like the oyster-shell scale, this insect passes the winter in the egg stage.

Treatment: Spray while trees or bushes are dormant with lime-sulphur solution (34 dilute), or when the insects hatch and are yet in the free-moving stage, during the latter part of May or in August, with dilute soap solution (33 a or 33 b) or with tobacco decoction (41 a).

III. DISEASES OF CURRANT.

CURRANT ANTHRACNOSE (*Pseudopeziza Ribis* Kleb.): This disease appears as small, dark-brown or black spots, usually on the upper side of the leaf. These spots enlarge and turn gray. The infected leaves turn yellow, then brown, and drop prematurely.

Treatment: Spray with Bordeaux mixture (42 a) or ammoniacal copper carbonate (43) as soon as the leaves are out, after the fruit has formed, and again ten days or two weeks thereafter.

THE LEAF SPOT (*Septoria ribis* Desm.): The leaf spot attacks both currants and gooseberries, producing brown spots with pale centers. These spots are thus distinguished from those developed in anthracnose, and they are also larger. Leaves infected drop prematurely and bushes may be defoliated in August.

Treatment: As for "Currant Anthracnose."

GOOSEBERRY.

I. CHEWING INSECTS.

THE CURRANT STEM-BORER: See under "Currant."

THE CURRANT WORM: See under "Currant."

THE GOOSEBERRY FRUIT-WORM (*Zophodia grossulariæ* Pack.): This insect is the larva of a pale gray, spotted moth which

has a wing expanse of about one inch. The adults appear about the latter part of April and deposit the eggs on the newly set fruit. The eggs hatch in a short time, and the larva burrows into the berry. In the course of time several berries are bound together by a silken thread. Infested fruit opens prematurely and becomes discolored. Currants are also attacked.

Treatment: Spray with arsenate of lead (27 a) as soon as the fruit is set, and again in ten days thereafter. Gather and burn infested fruit.

II. SUCKING INSECTS.

THE FOUR-LINED LEAF BUG: (See under "Currant.")

III. DISEASES OF GOOSEBERRY.

GOOSEBERRY MILDEW [*Sphærotheca Mors.*—*uvæ* (Schw.) B. & C.]: The powdery mildew of the gooseberry first appears on the young leaves and buds as a characteristic cobwebby covering (the mycelium or vegetative portion of the fungus), and later as a white powdery mass (the spores or fruiting portion). It attacks the young berries also, which become mis-shapen, rusty whitish, and dwarfed.

Treatment: Spray with Bordeaux mixture (42 a) or potassium sulphide (44) as soon as the leaves appear, and at intervals of ten days or two weeks thereafter until the fruit is half grown.

LEAF SPOT: (See under Currant.)

RASPBERRY.

For pests and diseases and their treatment see "Blackberry."

PESTS OF DOMESTIC ANIMALS.

I. CHEWING INSECTS.

THE BITING LICE OF CATTLE (*Trichodectes scalaris* Nitzsch): These are reddish, wingless insects, scarcely one-eighth inch in length, with flattened, elliptical bodies, short legs and a large head. They feed upon the hair or skin scales, blood clots, etc., found on the skin of the host.

Treatment: As for "Sheep ticks."

THE BITING LICE OF THE HORSE (*Trichodectes parumpilosus* Piaget): These insects resemble very closely those just described, but are somewhat larger. The body is a dusky yellow while the head, thorax and legs are reddish.

Treatment: As for "Sheep ticks."

II. SUCKING INSECTS.

THE CAT AND DOG FLEA. (See discussion of "fleas" under "household pests.")

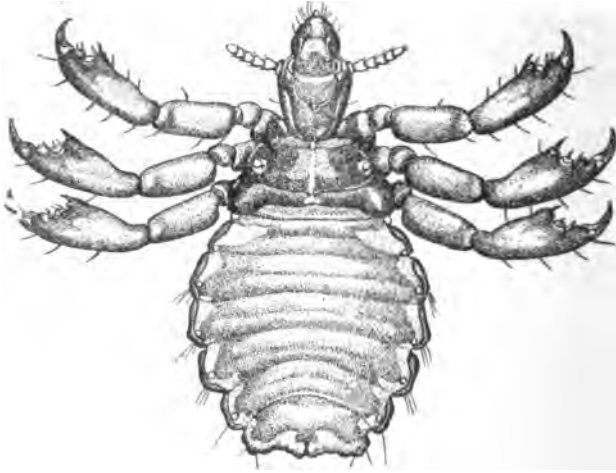


Fig. 2.—*Haematopinus urius*, the hog louse.

THE HOG LOUSE (*Haematopinus urius* Nitzsch): The hog louse is the largest species of parasite on domestic animals, adults reaching a length of an inch or more. They are conspicuous for this reason, and because of the thinness of the hair on hogs. The prevailing color is gray, and the body is broadly elliptical, while the head is decidedly pointed. These lice congregate behind the ears and along the back. When swine are frequently seen rubbing or scratching themselves, lice are evidently present.

Treatment: Use kerosene emulsion (32 a), or four per cent. creolin, or carbolic emulsion (36), or carbolic soap as a wash. Soak cloths with kerosene, and hang them as curtains in doors through which the hogs pass.

THE HORN FLY (*Haematobia serrata* Rob.-Desv.): The horn-fly resembles the common house fly, both in shape and color, but is smaller; adults are slightly less than one-quarter inch in length. These insects get their name from the fact that at certain seasons of the year and when very abundant they congregate at the base of the horns of cattle. In fact they will rest wherever they are beyond the reach of the cow's head or tail. They feed by piercing the skin of the host and drawing the blood. At such times they are generally found on the legs, back, and flanks. The eggs are deposited singly in cow manure, where the larvae develop. Pupation takes place in the ground.

Treatment: Spray the cattle lightly each morning with a mixture of fish-oil 100 parts; oil of tar 50 parts; and carbolic acid 1 part; mix

thoroughly before applying. Keep stables and barnyards well cleaned spread manure thin, as with a spreader.

HORSE BOT-FLY (*Gastrophilus equi* Fab.): The adult female fly, which somewhat resembles a honey bee, lays its eggs on the hairs of the fore legs, chest and lips of the horse. It is supposed that the horse bites off the eggs, which are then swallowed. They hatch in the stomach, where the larvæ attach themselves to the lining and may become sufficiently numerous to cause the death of the host.

Treatment: As a preventive measure, cut close the hairs on parts where eggs are deposited, and groom carefully. When animals become ill, consult a veterinarian about remedies.

THE HORSE FLIES (*Tabanidae*): Several species of flies of the family Tabanidae are known as Horse Flies. The adult male lives upon the nectar of plants, while the females subsist in the blood of animals. They generally lurk along woodland roads and are especially troublesome there. The eggs are deposited in mud, where the larvae or maggots feed upon organic matter.

Treatment: The most satisfaction is obtained by killing the flies as they attack the horses or cattle. Fly nets or cloth covers should be used.

THE OX WARBLE (*Hypoderma lineata* Villers.): Certain flies deposit their eggs upon the hairs of cattle, or on their food plants—so that the cattle lick off the eggs and swallow them. The larvae penetrate the gullet and make their way to the skin, just beneath the surface. Here they develop, cause a swelling and suppuration.

Treatment: Keep stables clean and avoid the accumulation of manure. Inject oil into the opening of the wound or use mercurial ointment and in a day or two remove the larva by pressure.

THE SHEEP BOT-FLY (*Oestrus ovis* Linn.): The Sheep bot-fly is a two-winged insect which resembles a house fly very much, but is considerably larger,—adults are about one half inch in length. They appear in June and July and deposit living maggots in the nostrils of the sheep. The larvae make their way upward in the nostrils until they reach a point which is between and a little above the eyes. There they attach themselves and change from a creamy white to a brownish color. When full grown the maggots pass down the nostril and fall to the ground where they pupate. The presence of these maggots in the head causes much distress to the host, and in severe cases a condition is produced which is known as the "staggers," which often causes the death of the host.

Treatment: Salt the sheep in a trough smeared with tar just above the salt, so they will rub their noses against the tar and make it too offensive for the flies to lay their eggs.

THE SHEEP TICK (*Melophagus ovinus* Linn.): This insect is of a brownish color, and is circular in outline and about one-quarter inch in length. It spends its entire existence on the host, which is always the sheep. Ticks may be transferred from one animal to another by rubbing against posts, or by clean sheep coming in contact with infested ones. Ticks are especially liable to infest lambs at shearing time.

Treatment: The opportune time to eradicate this pest is immediately after the shearing. This treatment is best done by immersing the sheep in some reliable dip, such as kerosene emulsion (32 a), or creolin solution (4 parts of creolin to 100 parts of water), or tobacco decoction (41 a). If all the members of the flock are properly treated they will remain free from ticks; therefore, additions to the flock should be given attention. Frequent dustings with pyrethrum powder (40 c) are beneficial.



Fig. 3.—*Stomoxys calcitrans*, the stable fly.

THE STABLE FLY (*Stomoxys calcitrans* Linn.): These flies are the cause of much discomfort and annoyance to live stock and of financial loss to the owner.

Treatment: Keep stables, poultry houses, pig pens, etc., clean and avoid the accumulation of manure or filth. Provide screens for doors and windows. Spray the animals lightly each morning with a mixture composed of oil of tar, 50 parts; fish oil, 100 parts; crude carbolic acid, one part. Mix thoroughly. Scatter a mixture of two parts kainit and one part either acid phosphate or "floats" on floors after cleaning, and also cover the manure pile.

PESTS OF THE HOUSEHOLD.

I. CHEWING INSECTS.

ANTS (*Formicidae*): Several species of ants come into houses—the most troublesome being the little red ants.

Treatment: Trace them to their nests and pour in a small quantity of carbon bisulphide, gasoline, benzine or kerosene (17, 21, 37). Put an alcoholic solution of corrosive sublimate along the path which they pursue. (One ounce of corrosive sublimate dissolved in one pint of alcohol.)

THE BOOK LICE: Several species of insects which belong to the family Psocidae are especially common in houses, where they occur among book and papers and in dusty corners. The adults are small insects with delicate wings and long antennae.

Treatment: Avoid the accumulation of dust. Expose books and papers to sunlight and air, and as a repellant use naphthaline or moth balls. Dust abundantly with fresh pyrethrum powder, and leave the room and closets closed an hour, then sweep up the powder and burn it.

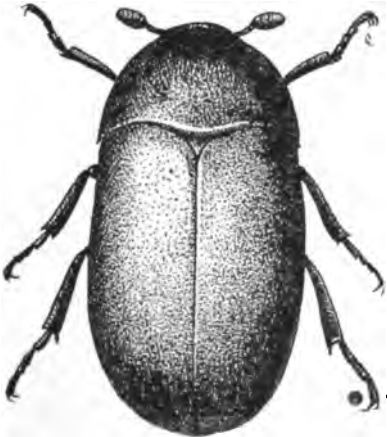


Fig. 4.—*Attagenus piceus*,
the black carpet beetle.

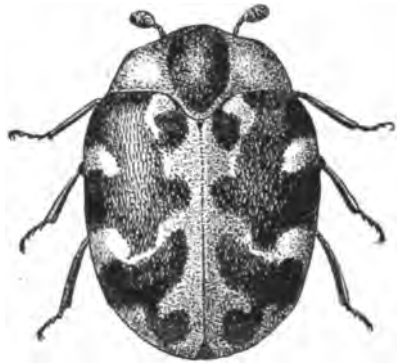


Fig. 5.—*Anthrenus scrophulariae*,
Buffalo moth.

THE CARPET BEETLE or "BUFFALO MOTH" (*Anthrenus scrophulariae* Linn): The adult carpet beetle is a minute, dark brown, oval insect. The larva is a hairy "worm" or grub which feeds on woolens and other animal products.

Treatment: Iron with hot flat irons over a wet towel on carpet. Brush and beat infested carpets, and expose several hours to the sun, and sprinkle edges of carpets and under furniture with an alcoholic solution of corrosive sublimate (one oz. corrosive sublimate to one pint

of alcohol), or fumigate with carbon bisulphide (37) or hydrocyanic acid gas (38). Where possible, use rugs rather than carpets.

THE MUSEUM PESTS (*Anthrenus* spp.): Several species of insects of the family Dermestidae are injurious to dried animal and vegetable products of all kinds. One species in particular is especially injurious to preserved specimens in museums and is hence known as the Museum Pest (*Anthrenus verbasci* Linn.) The adults are small, stout, heavily built, black beetles. The larvæ are elongate, hairy creatures. Both stages of these beetles are injurious.

Treatment: Store goods in pest-proof receptacles and use camphor, naphthaline or moth balls as repellants, or sprinkle with benzine or use carbon bisulphide to destroy them. Insect specimens are preserved by putting on them an alcoholic solution of corrosive sublimate.

THE CLOTHES MOTH (*Tinea pellionella* Linn. and *Tineola biselliella* Hum.): The winged form of these insects, commonly called "millers," makes its first appearance in May. Eggs are deposited in furs, feathers and woollens, on which the larvae feed, and of which they make a case in which to live and pupate.

Treatment: Infested clothes may be pressed with a damp cloth and hot iron, in which case the steam will kill the moths; or fumigate with carbon bisulphide (37), in a closed vessel, closet or room. In order to prevent the attacks of moths, clothes should be packed in paper bags or boxes, care being taken to paste strips of paper over the edges, or in cedar chests or in ordinary trunks in which moth balls or naphthaline should be placed. The clothes should be unpacked and examined occasionally. Brushing, and exposing to sunshine is excellent treatment. Sprinkle infested goods with gasoline.

THE FOUR BEETLES (*Trilobium confusum* Duv. and *T. ferrugineum* Fab.): The confused and rust-red flour beetles occur in flour, meal and other cereals. These beetles are about one sixth of an inch in length, reddish brown in color, and elliptical in shape. The larvae are slightly longer than the adults. Many commodities are attacked and made unfit for use.

Treatment: Infested goods should be placed in a barrel or other tight receptacle and fumigated for several hours with about one-half cupful of carbon bisulphide (37) placed on top. Then remove and air thoroughly. As a preventive measure, keep goods, subject to infestation, in tightly covered receptacles.

THE HOUSE CRICKET (*Gryllus domesticus* Linn.): The House Cricket, also known as the Hearth or Domestic Cricket, is an introduced species from Europe, and is the subject of Dickens' "Cricket on

the Hearth." It is yellowish brown, and hence is readily distinguished from our native black crickets.

Treatment: This cricket is generally a welcome guest, as it breaks the silence of the fire-side, but it is reported to be destructive to cloth goods, in which case it may be destroyed by allowing access to uncooked starchy vegetables, as sliced potatoes, poisoned with arsenic. This bait, should, of course, be placed so as not to be available to children or others who might not be aware of its poisonous character.



Fig. 6.—*Dermestes lardarius*, the larder beetle.

THE LARDER BEETLES (*Dermestes lardarius* Linn.): The larder beetle is a small, dark, mottled gray insect which deposits its eggs on preserved meats and stored provisions. These form the food of both the larvæ and adults. The larvæ are covered with numerous brown hairs, and are about one-half inch long when full grown.

Treatment: Remove adults and larvæ from infested goods by brushing. As a preventive measure rub cured meat with powdered borax or place substances in tight sacks. Fumigate infested goods with hydrocyanic acid gas (38).

THE MEAL MOTHS (*Plodia interpunctella* Huebn. and *Pyralis Farinialis* Linn.): These moths are often responsible for much destruction of stored foods. The former species attacks almost anything edible, while the latter limits its depredations to cereals, but often does infest hay, seeds, and dried plants.

THE INDIAN MEAL MOTH (*Plodia interpunctella* Huebn.): Resembles the common clothes moth very much, and is often mistaken for it. It will infest a very great variety of stored foods—seeds, nuts, dried fruits and chocolate. The adult moth has an expanse of about

five-eighth of an inch, and is cream color, with a reddish brown outer part to the fore wings.

THE MEAL MOTH (*Paralis farinalis* Linn.): is a larger moth, the expanse of wings being about one inch. The forewings are grayish brown and marked by two white lines; a dark brown spot occurs at the base and tip of each of the fore wings.

Treatment: Destroy all infested goods by burning or feeding to poultry or live stock and practice cleanliness to avoid re-infestation. This second precaution is especially applicable to the meal moth, as it is generally found where the surroundings are not as clean as they should be. Infested rooms should be fumigated with hydrocyanic acid gas, or infested material may be placed in a sufficiently large and tight receptacle and fumigated with carbon bisulphide.

THE MEAL WORMS: Two species of Tenebrionids or larvae of Darkling Beetles, are known as Meal Worms. *Tenebrio molitor* Linn., "the Yellow Meal Worm," and *T. obscurus* Linn., "the Dark Meal-Worm." They are yellow to brown in color, waxen, and resemble wire-worms in shape. The larvae of these beetles are the "worms" usually fed to cage birds.

Treatment: As for Flour Beetles.

ROACHES (*Blattella germanica* Linn. and *Blatta orientalis* Linn.): These well known pests live upon starchy food and glue, and may be looked for wherever such food is accessible to them. They hide by day and become active at night when they go forth to feed.

Treatment: Dust powdered borax or hellebore (31 a) or spray an alcoholic solution of corrosive sublimate (one ounce of corrosive sublimate in one pint of alcohol) into their haunts. Use such preparations as equal parts of plaster of Paris and powdered sugar or, in badly infested places, fumigate with carbon bisulphide (37), or hydrocyanic acid gas (38). Place as food a mixture of white arsenic one part; powdered sugar, two parts, and flour, twenty parts. Dust powdered borax around their haunts.

THE SILVER FISH OR FISH "MOTH": (*Lepisma saccharina* Linn., and *L. domestica* Pack.) These creatures are among the most primitive insects. They are wingless but possess three pairs of legs, and there are three long, thread-like growths extending from the tail end of the body, hence these insects are often called "bristle-tails." The body is covered with smooth scales of a pearly luster, hence the name "fish" moth. Adults average from one-fourth to five-eighth inch in length.

They feed on starchy material, such as is found in the binding of books and under wall paper.

Treatment: In infested places dust pyrethrum powder (40 a). Expose infested books and other goods to the sunlight and air. Treat as directed for Roaches.

II. SUCKING INSECTS.

THE BED BUG (*Cimex lectularius* Linn.): This well known and detested insect hides during the day in joints of furniture or in cracks in walls and floors and comes forth at night in search of food.

Treatment: Sprinkle or spray their hiding places with a solution of one ounce of corrosive sublimate to one pint of alcohol, or use gasoline, turpentine, benzine or kerosene (17 or 21), or fumigate with hydrocyanic acid gas (38). (Send for our special article on "Household Fumigation" before trying to use this deadly gas). Insect powder dusted between sheets and under pillows will give relief in a "buggy" hotel.)

THE CHEESE OR HAM SKIPPER (*Piophilæ casei* Linn.): This is the larva of a small fly of a shining black color. The larvae are white cylindrical maggots which feed on cheese and meat. By bringing the two ends of the body together and suddenly straightening as a spring, the maggots are able to throw themselves some distance; hence the name "skipper."

Treatment: "As for the "cheese mite." Remove with a stiff brush. Rub meat with powdered borax after curing.

FLEAS: Two species of fleas are apt to infest houses. These are the house or human flea (*Pulex irritans* Linn.) and the dog and cat flea (*Ctenocephalus canis* Curt.) The latter, however, appears to be more prevalent. The common host is the dog or cat, among the hairs of which the adult fleas deposit the eggs. These fall readily from the host, and naturally are most numerous where the latter sleeps. The larvae live in dust, lint, and other material in the carpet, corners, and cracks in the floors, and when full grown seek the host.

Treatment: Provide a rug for the dog or cat to sleep on, and remove the rug frequently; shake it and burn the dust thus collected, or dust it over grass. Dust the animals with pyrethrum. In infested rooms dust the floors and carpets with pyrethrum, close the room, and in an hour sweep carefully and burn the sweepings. As a further means, a sprinkling of benzine or gasoline may be used, and if then the fleas are not destroyed the floor covering should be removed and the floors thoroughly cleaned with three per cent. creolin solution. Clean, fill and paint over all crevices and cracks. Put sticky fly paper on the floor under furniture; fumigate with hydrocyanic acid gas (38). Where fleas are in a cellar or basement, spray thoroughly with three to five per cent. creolin solution.

THE FRUIT FLIES (*Drosophila* spp.): These are small brown flies of several species, belonging to the genus *Drosophila*, and which breed in decaying and fermenting fruit, canned fruit, vinegar and fermented liquors. The larvae are small, slender, white maggots, which transform into brown pupae. The period of development from egg to adult is about twenty days.

Treatment: Keep windows and doors screened. Canned and other goods subject to infestation are best preserved by being properly sealed and covered. Even the smallest openings must be closed. Infested rooms should be treated with burning pyrethrum powder. Promptly remove decaying fruit.



Fig. 7.—*Musca domestica*, the house fly.

HOUSE FLIES (*Musca domestica*, et al.): Although the common house fly (*Musca domestica* Linn.) is the chief intruder of the two-winged insects, several species of flies (among them *Pollenia rudis* Fab., the cluster fly) are in the habit of entering houses and causing more or less annoyance, especially in the fall. Other flies, such as the blue-bottle (*Calliphora erythrocephala* Meig.) and the blow-fly (*C. vomitoria* Linn.), are more or less common all summer. The house fly breeds in manure and filth, while the blow fly is especially unwelcome because it deposits its eggs in meats if available. The mouth parts of the common house fly are fitted for sucking up liquids, and they are very annoying, although not able to bite. In addition, this fly pollutes food and carries the germs of such diseases as typhoid fever and diphtheria.

Treatment: The best preventive measures are thoroughly and frequently cleaning away all filth, screening windows and doors and

using sticky fly paper. A solution of potassium bichromate (1 dram in 2 oz. of sweetened water), or of a few drops of formalin in water, kills flies when placed where they can drink it. House flies breed preferably in manure. One stable will supply sufficient flies to infest a whole neighborhood; consequently manure should be removed frequently or kept tightly covered and sprinkled over with lime or better, with ground phosphate rock.

MOSQUITOES (*Culicidae*): Few insect pests of the household are more disliked than are mosquitoes. The Pennsylvania species belong to several genera, one of which (*Anopheles*) includes those species that transmit malaria. Adult females hibernate in cellars, hollow trees, and in other sheltered places. The eggs are deposited singly in boat shaped masses in mud or on the surface of water. The larvae, known as wrigglers, are aquatic, but must come to the surface to breathe.

Treatment: As far as possible destroy the breeding places. This can be done most satisfactorily by drainage. However, a very successful measure is to cover the surface of the water with a thin film of kerosene, which causes the wrigglers to drown, since they are unable to secure access to the air. When this method is not practicable, as in the case of water used for drinking purposes the introduction of small fish will serve to keep the mosquitoes in check. Mosquito bar or fly screens aid materially in excluding the insects from buildings. In infested rooms the adults may be destroyed by burning pyrethrum powder. Remove all underbrush, leaves, and tall grass to eradicate the moist situations where the mosquitoes pass the day, and drain all swamps. Oil of pennyroyal or of citronella repels them.

PUNKIES (*Ceratopogon* spp.): These are minute flies which are also known as gnats and midges. They resemble the mosquitoes somewhat, but differ in that the latter have scales on the veins of the wings. The larvae develop in the sap of injured trees and in decaying vegetable material, such as fallen leaves and bark. The adult punkies are found in woodland where the dampness is congenial to them and where they occur in swarms at times. They are provided with biting mouth parts, and are especially annoying to persons, such as campers, who frequent forests or sojourn in woodland.

Treatment: The most practical measures are of the nature of repellants. Smudges will serve to ward off the insects. Spray or sprinkle the surroundings with a dilute solution of creolin or carbolic acid. Such preparations as oil of pennyroyal or of citronella, if liberally applied to the skin, give relief by driving the insects away.

III. OTHER PESTS.

THE CHEESE, HAM AND FLOUR MITES (*Tyroglyphus longior* Linn., and *T. siro* Gerv.): These minute colorless creatures, unlike the insects, possess eight legs. They are especially common in cheese, dried meats and other foods. They multiply so rapidly that a cheese when once infested may become a crumbling mass mixed with the swarms of the crawling mites.

Treatment: Cleanliness is the first requisite. Cut out and burn the infested parts. In badly infested rooms fumigate with burning sulphur, carbon bisulphide (37), or hydrocyanic acid gas (38).

THE HOUSE CENTIPEDE (*Scutigera forceps* Raf.): This is one of the "Thousand-Legged Worms," of a grayish yellow color, and with fifteen pairs of long, thread-like legs. It is a very active creature, and is provided with strong mandibles, which are especially useful in capturing its food. This consists of such insects as roaches, flies, and bed bugs. This creature is most frequently found in rather damp situations such as about water and drain pipes, and in cellars. It is not venomous, as is often supposed.

Treatment. It is readily seen that the House or Skein Centipede is a valuable creature in the house, but it may not be considered desirable because of its appearance. They can be controlled by destroying them when seen, and by keeping the house free from hiding places.

MICE: The Common House Mouse (*Mus musculus* Linn.) is so similar to the rat in habits that what may be said of one applies almost equally well to the other. Like the rat, the House Mouse is an introduced species from Europe. See discussion under "rats."

Treatment: For combating mice, traps properly set are as successful as any other method. The little "sure catch" trap is reliable and has the advantage of almost always killing its victim at once.

RATS: The Black Rat (*Mus rattus* Linn.), introduced about 1544, is now almost completely replaced by the Brown or Norway rat (*Mus norvegicus* Erxleben), introduced about 1775 from Europe. The habits and depredations of these mammals are too well known to need comment. Suffice it to say that although they do a valuable work as scavengers, the decision is against them because of the property they destroy and because they are carriers of diseases, of which the Bubonic plague is most notable.

Treatment: Concrete construction is being used more extensively each year, and in addition to many other desirable features, it is rat-proof. Concrete walks, walls, and floors for pig pens, poultry houses, and cellars are therefore desirable. In premises already infested, persistent trapping results in success. All-metal traps,

and particularly those that operate on the principle of the "guillotine," are recommended. These improved traps may be purchased in most hardware stores. Such poisons as arsenic and strychnine may be mixed with food and placed in the holes or runways. Poisons containing phosphorus are not recommended. An objection to most poisons is found in the fact that the victims are apt to die and decay in the holes. Barium carbonate, a white substance analogous to calcium carbonate (limestone), is both cheap and effective and is slow-acting, thus allowing the poisoned rats to get well off the premises in search of water. It should be mixed with meal. In setting traps or poisons, success can be had by persistence, and by remembering that rats are of a suspicious nature, and precautions must be taken accordingly.

HOUSE PLANTS.

1. SUCKING INSECTS.

APHIDS (*Aphididae*): Several species of aphids or plant lice attack house plants. They are readily recognized by their pear-shaped bodies, and they are generally less than one-eighth inch in length. The legs and antennae are long and slender, while both winged and wingless forms occur. These insects live by injecting a poisonous saliva and sucking out the modified juices of plants, and where numerous prove a great injury to the latter.

Treatment: Spray with soap solution (33a) or with tobacco decoction (41a). Fumigate in a closed vessel with tobacco smoke. Insects may be washed from plants by a strong jet of water.

MEALY BUGS (*Pseudococcus citri* Risso. and *P. longispinus* Targ.) These two species of mealy bugs are the commonest ones on house plants. They measure less than three-sixteenth inch in length, are covered with a white powdery substance, and numerous pointed processes extend from the edge of the elliptical body.

Treatment: As for aphids, or kill by touching each with a very fine brush dipped into kerosene.

SCALE INSECTS (*Coccidae*): House plants are subject to the attack of several species of scale insects, particularly the Soft or Lecanium Scales. Like the plant lice, they subsist by piercing the plant and sucking out the juices, modified by a poison which they inject into the plant.

Treatment: Spray or apply with a brush or sponge once every few days for several weeks, whale oil soap solution (33 b) or tobacco decoction (41 a) or a solution of ivory soap to which have been added a few drops of ammonia.

II. OTHER PESTS.

NEMATODES OR ROOT-WORMS: These are slender, white, thread-like worms that infest the roots of plants and cause considerable injury.

Treatment: Make holes in the soil and pour a tablespoonful of carbon bisulphide (37) into each, then cover with soil; or re-pot infested plants with soil not infested.

PESTS OF THE LAWN.

I. CHEWING INSECTS.

ANTS: See under "household pests."

ARMY WORMS: The caterpillars of the genus *Leucania* are known as army-worms because they are found in great numbers and sometimes move together as they feed. *Leucania unipunctata* Haw. is the species which commonly and seasonally occurs in grass and is often detrimental to lawns. The larvae are "cutworms" of a brownish drab color with darker stripes running lengthwise, and when full grown are about one and one-half inches long.

Treatment: One or two applications of a spray of lead arsenate (27 a) to the lawn will suffice to destroy the caterpillars.

THE WHITE GRUB OR GRUB WORM (*Lachnosterna* spp.): Frequently in the spring evenings there come buzzing about lights, large, heavy, brown beetles, called June Bugs or May Beetles. These insects fly chiefly at night and feed on the foliage of trees and shrubs and lay their eggs chiefly in sod in pastures or in gardens.

The larvae are known as "white grubs" or "grub worms." They live two years in the soil, where they feed upon roots. The adults come forth in the spring.

Treatment: Top dress the soil with kainit, applied at the rate of 1000 pounds to the acre, or nitrate of soda 200 pounds to the acre. Pour carbon bisulphide (37) into holes made in the ground about four to the square yard. Try poison bran mash, as directed for cut worms, put into the soil. Let pigs root in infested soils. Preserve skunks and birds. Plow late in fall.

III. OTHER PESTS.

THE CRAYFISH OR FRESH-WATER CRAB (*Cambarus* spp.): The Crayfish, also called Crawfish and Fresh-water Crab, is often detrimental to lawns, especially in damp situations, where it makes vertical holes, which fill with water and in which the Crayfish hides. In Pennsylvania west of the Allegheny Mountains, the prevalent species builds mounds about the mouth of the burrow and in this

respect differs from the eastern species. These animals are beneficial in cleaning out spring channels, and also as food for fish, but they may also drain dams.

Treatment: Pour a few teaspoonfuls of carbon bisulphide (37) into each hole and the occupants will soon be destroyed.

THE EARTHWORM (*Lumbricus* sp.): The Earthworms frequently cause damage to lawns by making holes and depositing their castings on the surface. Then, too, they often cut off parts of plants and draw them into the holes, and may be quite injurious in gardens.

Treatment: Scatter air-slaked lime or wood ashes or salt or pour brine over infested ground (avoid too much salt or too strong brine); or fumigate ground by sinking holes into the soil, one-half foot or one foot in depth, using a pointed stick like a sharpened broom handle, and into each hole pour one-half teacupful of carbon bisulphide (37).

THE COMMON MOLE (*Scalops aquaticus* Linn.), and **THE STAR-NOSED MOLE** (*Condylura cristata* Linn.): These two species occur within the Commonwealth. They are short, heavy-set mammals, with concealed, vestigial eyes, fore feet broadened for digging, and, in fact, fitted especially for a subterranean life. By many persons the moles are confused with the Meadow Mice or Voles, which are short-tailed field mice and which make runways in grasses on the surface of the ground and eat vegetation, often gnawing trees. The moles feed upon earth worms, grub worms, and other insects in the soil. They are accused of devouring roots, but investigation shows that this work is done by mice or voles which get into the mole runways. Moles do, however, injure lawns by making ridges, and by loosening the ground so as to injure the roots of grass and shallow-rooted plants.

Treatment: By tramping down the ridges and closing the runways the moles will be driven to other places. The market now offers several forms of traps, especially adapted to capturing moles, and which are very successful. However, it is more desirable to drive away the moles than to kill them, since they are beneficial animals.

INSECTS ATTACKING MANKIND. (See also "Pests of the Household.")

I. SUCKING INSECTS.

THE BODY LOUSE OR GRAY-BACK (*Pediculus vestimenti* Leach): This insect is very frequently confused with the succeeding species, which it resembles very much in shape. However, it attacks the host only when in search of food and at other times secretes itself in the seams of the clothing, where the eggs are deposited.

Treatment: Cleanliness is the first requisite to eliminate these pests. Steaming, boiling or baking the clothing will serve to kill the insects, while dipping in gasoline or benzine will serve the same purpose. This treatment should be repeated several times, at intervals of about a week to insure killing the insects that may hatch from eggs, present at the time of the first treatment.

THE CRAB-LOUSE (*Phthirius inguinalis* Leach.): The crab-louse is a whitish insect about one-eighth inch in length. The well developed legs are provided with strong claws by which the insect clings so that it is practically impossible to remove it without displacing the hair to which the louse is attached. It is generally confined to the pubic region, but may be found on other parts of the body, excepting the scalp.

Treatment: A thorough application of mercurial ointment or of the tincture of larkspur will generally suffice to kill the adults. To kill the lice that may hatch from the eggs, the application should be repeated in the course of several days.

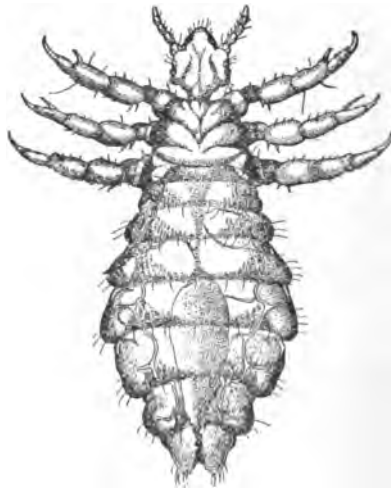


Fig. 8.—*Pediculus capitis*, the head louse.

THE HEAD LOUSE (*Pediculus capitis* De Geer.): This insect confines itself to the head. It is whitish in color. As with the preceding species, the eggs (nits) are glued to the hair.

Treatment: Cleanliness is of course the first requisite to eradicate this pest. A liberal use of vaseline, followed by tincture of larkspur, should suffice and should be repeated several times at intervals of several days.

THE HOUSE OR HUMAN FLEA (*Pulex irritans* Linn.): The house-flea hides in the adult state in clothing and bedding, and attacks the host when in need of food. The eggs and larvæ develop in

dust in corners and in floor crevices. See "fleas," under "Pests of the Household," for additional notes and treatment.

(See also "Pests of the Household.")

POULTRY PESTS.

I. CHEWING INSECTS.

THE COMMON HEN LOUSE (*Menopon pallidum* Nitzsch): About eight species of lice are known to infest chickens, but this species is by far the most prevalent. It is scarcely $\frac{1}{8}$ inch in length, slender, and of a light yellow color. It feeds upon the young feathers, and on scaly and scurfy material upon the skin of the host. The eggs are deposited among the feathers. It is a very active insect and poultry soon become infested by coming in contact with infested fowls.

Treatment: Apply pure lard containing a few drops of carbolic acid to the heads of chicks and under the wings of older birds. Supply dusting boxes, adding sulphur and tobacco to the dust. Hold fowls by the feet and sift into the feathers flowers of sulphur and tobacco dust, to which has been added pyrethrum (40) or hellebore (31.) The poultry house should be given attention, as directed below under "red mites."

II. OTHER PESTS.

GAPES. Certain small worms (*Syngamus trachealis*) live within earth worms and when the latter are eaten by chicks the gape worms develop and lodge in the windpipe of the chick as thread-like creatures.

Treatment: Destroy earth worms, as recommended under Lawn Pests, or keep chicks on board or cement floors. Use lime freely where they run and dust themselves. Feed chicks with a mixture of one teaspoonful of turpentine to a pint of cornmeal. Strip the shaft of a feather until just the tip remains. Dip this into kerosene and insert the tip deep into the windpipe, or extract the worms by the use of a loop of horsehair inserted into the windpipe and then withdraw by a whirling motion. Or, place chicks in a box, cover with a burlap sack and through this dust air-slaked lime. Allow chicks to inhale the lime-laden air for a few minutes; repeat in a few days.

THE RED MITE OR THE POULTRY TICK (*Dermanyssus gallinæ* De Geer.): The Common Hen Louse is a true insect, while the "red mite" belongs to the Arachnida,—the class which includes the Spiders, Scorpions and Harvest-men. These creatures, in the adult form, possess eight legs, and the body is not divided into distinct divisions. The Poultry Tick is slightly more than 1-16 inch in

length, and is grayish white in color. It lives by sucking the blood of the host, and it is then that the mite becomes red. During the day the mites conceal themselves in cracks and crevices, and at night crawl upon the roosting fowls.

Treatment: Keep poultry houses clean and provide movable roosting poles and smooth drop boards, which should be scraped every few days, or, better, every morning. Spray or wash the interior of poultry houses with lime-sulphur solution (34 dilute) or kerosene emulsion (32 b) or kerosene (17) or carbolic emulsion (36), being particular to spray into cracks and crevices and all roosts.

SHRUBBERY PESTS.

I. CHEWING INSECTS.

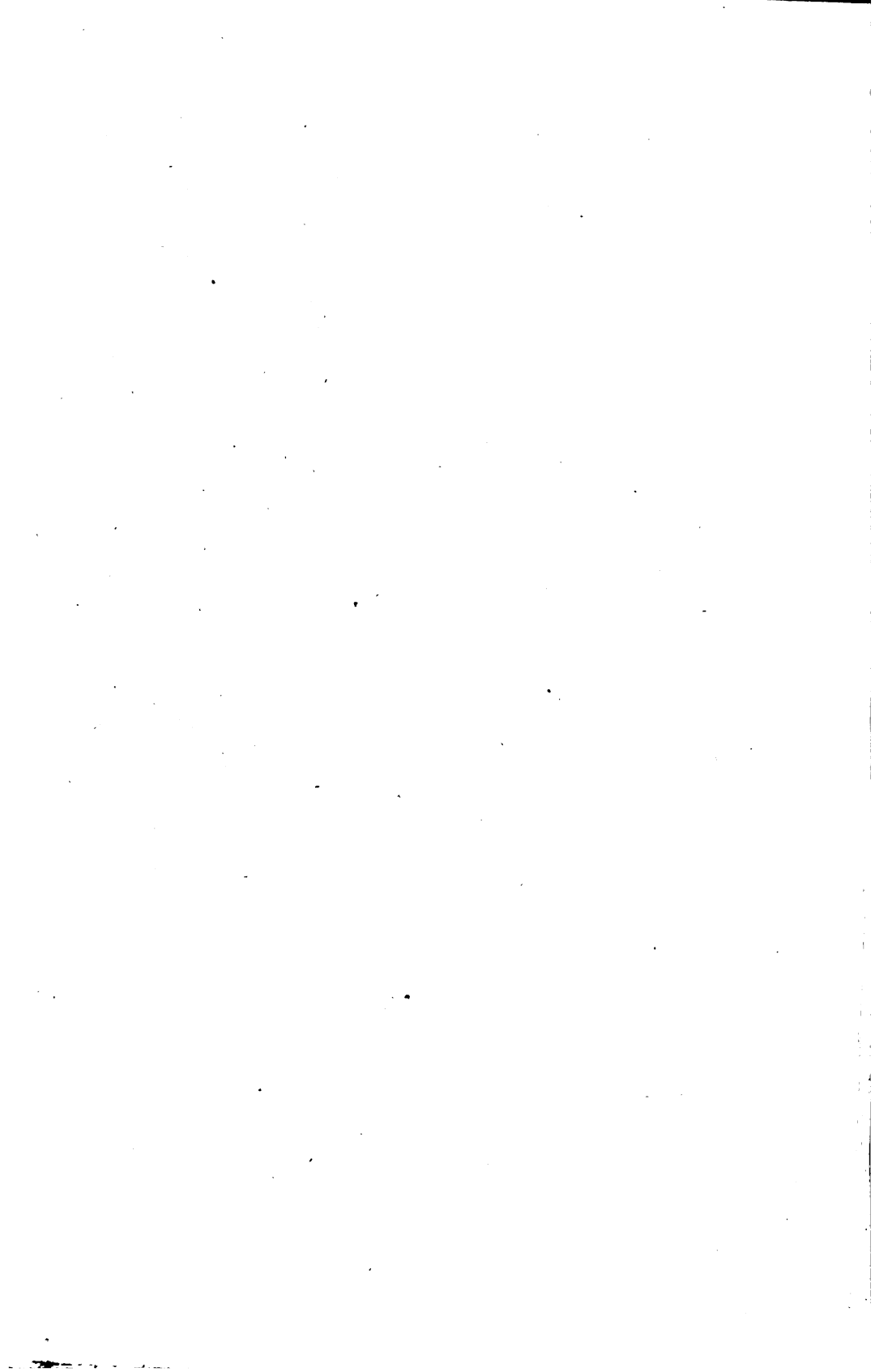
CATERPILLARS. The larvæ of moths and butterflies (*Lepidoptera*) are commonly known as "caterpillars." For no small number of species of such insects the shrubs furnish food, and in many cases these plants are greatly retarded in growth or rendered unsightly.

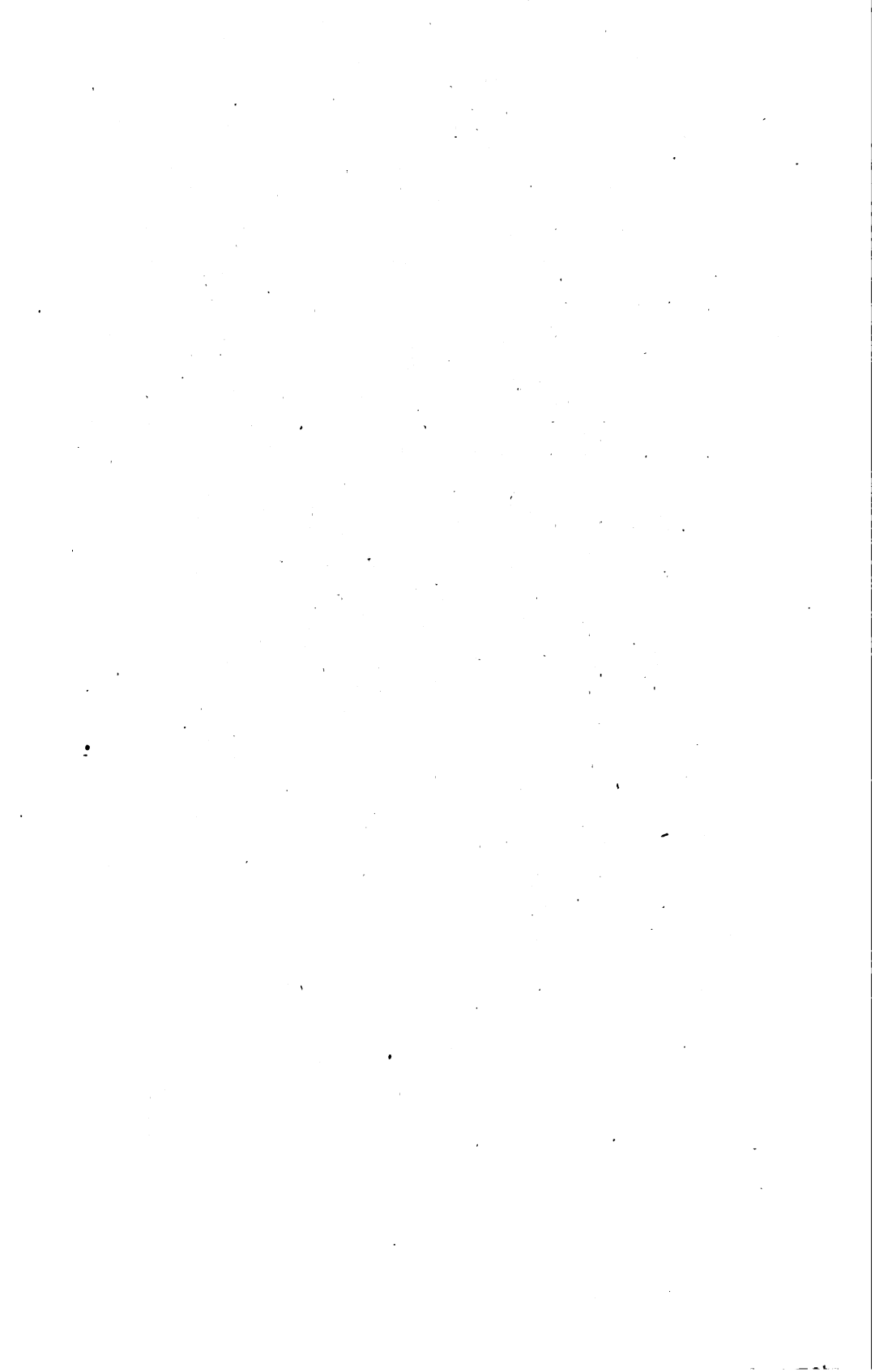
Treatment: Inasmuch as all the caterpillars are chewing insects, they can be controlled by spraying the foliage with lead arsenate (27 a) or Paris green (26 a). In limited cases hand-picking is satisfactory. When the pests are few remove them by hand and crush them on the ground. Spray when pests are very young.

THE SAN JOSE SCALE (*Aspidiotus perniciosus* Comst.) This insect occurs on a variety of plants—upwards of 140 species being included. Among these are many fruit, forest and shade trees; fruit-bearing and ornamental shrubs, and sometimes even herbaceous plants.

Treatment: Prune back in proportion to injury, and spray when dormant with the lime-sulphur solution (34 dilute), as for Scale on apple trees.

OTHER INSECTS: Shrubbery is liable to be infested by various insects such as attack fruit and forest trees (previously discussed). Owners should study the habits and remedies for the respective pests, as elsewhere discussed. For example, the Oyster Shell Scale is a serious enemy of the Lilac. For the remedy see discussion of this pest under "Apple" in Bulletin No. 6, Volume II. The Lilac is injured by a stem borer. Apply the remedy given for the Borer of Currant, discussed under "Small Fruit" of this number.





THE BI-MONTHLY

ZOOLOGICAL BULLETIN



OF THE

DIVISION OF ZOOLOGY

OF THE

PENNSYLVANIA DEPARTMENT OF AGRICULTURE

VOL. III.—No. 2.

SUBJECTS: { I. Fumigating for House Pests.
II. Inspection of Nurseries and
Apiaries in Pennsylvania.

MARCH, 1913.

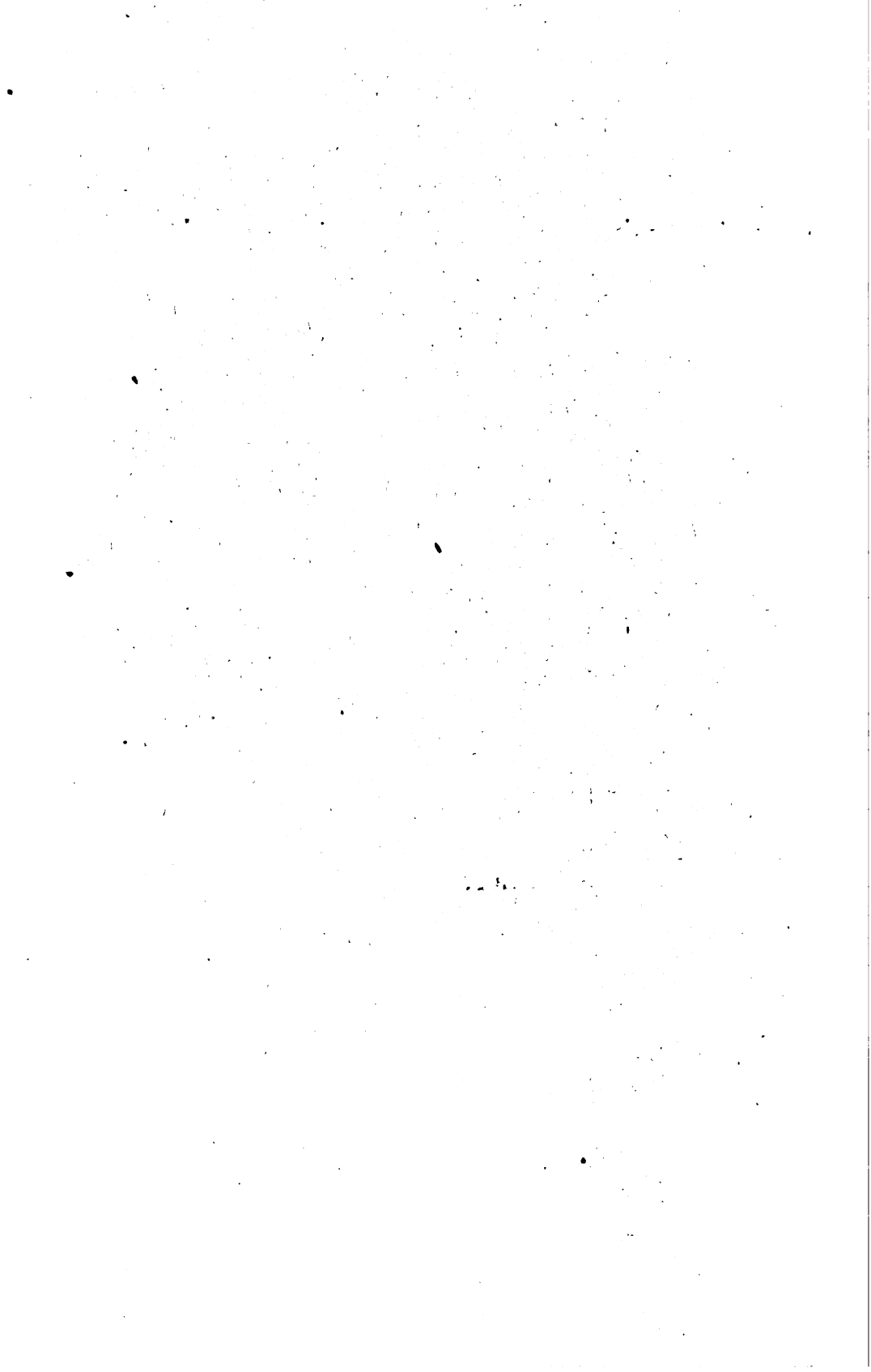
H. A. SURFACE, D. Sci., Economic Zoologist,
Editor

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under the Act of June 6, 1910.*

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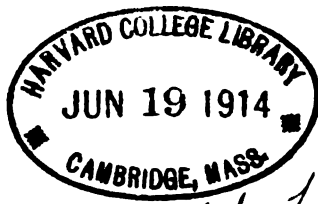
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PREFACE

The Bi-Monthly Bulletins of the Division of Zoology have been considerably delayed during recent months on account of the remarkably heavy pressure of printing, due to the present session of the State Legislature. This has been unfortunate and unavoidable, and consequently the delay will be excused by the many persons who have been making inquiry as to why the Bulletins have not reached them earlier or regularly.

No names have been dropped from the mailing list. Names will not be dropped without due notification. There is room for more names to be added to the list, but no one should send a name and address without notifying the persons named that the Bulletins will be sent to them as issued.

This Bulletin contains reports of the various features of the Inspection of Nurseries, Importations of Plants, Greenhouses and Apiaries. Attention is also called to the list of Licensed Nurserymen of Pennsylvania, as published in this Bulletin, together with the number of acres of nursery stock grown by each and the respective certificate of license number granted by this Department.

An additional feature of this Bulletin is the list of Pennsylvania Tree Dealers, or persons buying and selling trees. These must be licensed, and are required to obtain trees only of certified and licensed growers.

One of the most important subjects now before the people of this State is the production of food for mankind, in which fruits play a most important part. Part of the work of this office is devoted to showing how to grow better fruits, with special reference to pest suppression, although the efforts are not confined to horticultural lines.

In relation to the fruits the bees are of great importance. The Voluntary Apiary Inspection was undertaken last year, and was given considerable attention, especially in consideration of the fact that even the expenses of the inspectors were not paid for this service. The total number of apiaries so inspected amounted to 157, while the number of diseased apiaries was 18.

All of the Inspection and Supervision Work is to be continued during the coming year. Any persons desiring additional information on this or related subjects should address

H. A. SURFACE,
Economic Zoologist,
Harrisburg, Pa.

FUMIGATING FOR HOUSE PESTS.

During the summer time insect pests in buildings are liable to multiply to a very annoying or injurious extent. This applies not only to those species which directly attack mankind, but also to those which affect stored products, food stuffs, clothing, milling stuffs, and even drying plants, like tobacco. All such pests living in a room or building that can be fairly well closed or made as tight as the average building is made for the convenience of human occupation during the winter time, can be fumigated with a deadly gas that will kill the insects within two hours and leave the rooms or building in nice condition, without any injury whatever to any cloth, metal, woodwork, painting, varnish, foodstuffs, flour, grain or other material that may be in the building, excepting living plants, animals and insects. (One correspondent has reported tarnishing some brass work by the fumes).

Knowing that fumigation is so efficient, and, in fact, so cheap in comparison with the loss that may be sustained without it, it is remarkable that persons permit such pests as the Cigarette Beetle to damage stored tobacco, the Mediterranean Flour Moth to attack flour in mills or store rooms, the Skipper to injure meat, the Larder Beetle to injure meats, skins or furs, the Buffalo Carpet Beetle or Clothes Moths to injure clothes, fabrics, woolen goods or furs, or Ants, Fleas, Bedbugs or even House Flies to infest their premises. All these, as well as Mice and Rats, can be destroyed quickly and effectively and comparatively cheaply by fumigation, if the building can be well closed for at least two hours.

This statement is made upon the authority of H. A. Surface, State Zoologist, at Harrisburg, Pa., who has had considerable experimental and practical experience in fumigating mills, granaries and houses for nearly all the pests mentioned.

It is against the very common and annoying foe of mankind, commonly known as the Bedbug, but secretly whispered as the "Red Rover," and other names, that the State Zoologist sounds a word of warning at this time. It is too frequently the common belief that Bedbugs infest only houses of filthy or careless persons. The fact is that these creatures are liable to move among the best of society, and their presence is to be regarded more as a calamity or affliction to be remedied than as a disgrace or infliction to be tolerated.

There is no worse pest directly attacking mankind than the Bedbug, which while he should be taking his necessary rest in comfort sinks its fiery bill into his skin and causes pain and smarting so

irritating as to be almost like that of burning by fire. This infliction is generally during the summer months when the discomforts of hot weather are greatly accentuated by such pests. Little children and especially helpless babes are liable to be made the particular objects of attack by these despicable pests, and special irritation may ensue from the places where the beaks of the bugs were inserted. This is liable to lead to skin rash, and in some cases even to blood poisoning. It should also be remembered that the suctorial pests attacking mankind are particularly liable to inject disease germs, and it is believed that there are certain diseases that are liable to be carried or disseminated by the insect under discussion.

As this insect bites a person it inserts its sharp beak, and like other suctorial insects injects a poisonous saliva into the blood system of its victim, and then sucks out the modified liquid. It is not the process of puncturing or inserting the beak through the skin that causes the acute suffering, but it is the irritation that comes from the injection of the poisonous saliva that the victim is caused such conspicuous blotches or wounds. The sufferer may feel as though on fire at the places attacked, and this burning may continue for two or more days with considerable swelling and reddening of color. It is partially allayed by washing with a solution of alcohol or formalin, or covering with a paste of baking soda and water.

Travelers or persons obliged to sleep temporarily in infested beds should remember that they can obtain freedom from infliction by these pests by sprinkling between the sheets a small amount of insect powder, such as Pyrethrum or buhac, which will not be objectionable to the human occupants of the bed, but will repel these pests.

There are, of course, many methods of local treatment for Bedbugs, such as the application of benzine, gasoline, turpentine, alcohol, and mixtures of these substances, and especially a solution of mercuric bichloride, which is the basis of most of the so-called Bedbug ointments sold on the markets. This is, of course, corrosive sublimate, and is really of value in destroying the pests when it reaches them or the places where they are liable to inhabit. However, when a room is once really infested with such troublesome pests it is very difficult so to clean it as to destroy them entirely, excepting by fumigation. This does not demand tearing to pieces of beds and scattering clothing, etc., about the room for the purpose of the gas entering, but if trunks, bureaus and boxes be merely opened the gas will enter to sufficient extent to do the desired work of cleaning out and killing all insects and other creatures which may be therein.

In fumigating, various materials are recommended, but none is so certain in effect on the pests, but although at the same time so speedily injurious to the operator if breathed, as the gas known as hydrocyanic acid gas, made by putting an acid, such as sulfuric

acid, upon cyanide of potassium, commonly known as "prussic acid." All the chemicals needed for effective fumigation consist of cyanide of potassium, sulfuric acid and water, and all the materials necessary are stone jars or other earthen vessels, cloths or newspapers under them for protection of carpets, and a pair of scales for weighing to ounces.

The amount of material to use is one ounce of cyanide of potassium, two ounces of sulfuric acid, and four ounces of water for each one hundred cubic feet of space. To determine this, multiply together the length, breadth and height of the room to fumigate, and divide this by one hundred. This will give the number of ounces of cyanide of potassium needed. Twice this will be the bulk (fluid ounces) of the sulfuric acid, and twice the acid bulk will be the amount (fluid ounces) of water. These materials can be bought at drug stores or of wholesale druggists or larger chemical companies of our cities. The sulfuric acid may cost four or five cents per pound, and the cyanide of potassium may cost from thirty to fifty cents per pound, but can be bought in quantity for about twenty-five cents per pound.

In fumigating a room or building enough vessels should be used that it will never be necessary to use more than two pounds of cyanide of potassium in each vessel, and better results might come from using enough vessels to reduce the poison in each to not much over one pound of the cyanide.

Two pounds or thirty-two ounces of cyanide of potassium would require four times as much sulfuric acid, or sixty-four fluid ounces (2×32), which means four pints or one-half of a gallon, and this would require twice as much water or one gallon, which means one and one-half gallons for the liquid.

It is certain that the chemical action will cause the liquid to bubble over the vessel if a jar as small as a two-gallon jar should be used. It should be one that will hold at least twice the amount of liquid required, and still larger would be better. This means that a three-gallon jar would be required to hold the necessary liquid and cyanide of potassium required for fumigating where there are two pounds of cyanide to be used. In order to make sure against such boiling over it would be better to use a five-gallon jar in such a case, and where there is only one pound of cyanide of potassium used, calling for thirty-two ounces of sulfuric acid and sixty-four ounces of water, it will be better to use a three-gallon jar instead of one holding only two gallons.

As an example of the method of computing the amount of material needed, let us suppose that we wish to fumigate a portion of a house containing four rooms, A, B, C and D, of dimensions as follows:

A = 18 x 20 x 9 ft., containing 3,240 cubic feet.

B = 18 x 14 x 9 ft., containing 2,268 cubic feet.

C = 14 x 14 x 9 ft., containing 1,764 cubic feet.

D = 14 x 20 x 9 ft., containing 2,520 cubic feet.

	A	B	C	D	
Dimensions,	3,240	2,268	1,764	2,520	= Total, 9,792 cu.ft.
Cyanide needed, ..	32.4	22.68	17.64	25.20	= Total, 97.92 oz.
Sulfur. Ac. needed,	64.8	45.36	35.28	50.4	= Total, 195.84 oz.
Water needed,	129.6	90.72	70.56	100.8	= Total, 391.68 oz.

The above tabulation shows how the amount of material for each room is to be computed, and also how the total amount is to be ascertained. Of course, if there be other rooms in the house to fumigate, whether they be on the same floor or not, their dimensions should be measured exactly, the cubic contents computed, the amount of material for each room calculated for itself, and the total ascertained by adding together the quantities desired for the several rooms individually. Upon this basis of computation, and counting the Cyanide of Potassium and Sulfuric Acid at the highest figures which we have been quoted for this purpose, viz: 40 cents and 6 cents respectively, the cost of the Cyanide of Potassium for such a building would be \$2.45, and the cost of Sulfuric Acid would be \$0.73, making the full cost of the fumigation only \$3.18. Considering the fact that this will give freedom from unspeakable household pests for an entire season, it is not to be considered a high price to pay for the luxury and comfort of relief from such troubles.

Having computed the required amount of materials and ordered them to be sent packed in separate packages, by freight, as Sulfuric Acid will not be carried by express, you can proceed with the arrangements. When they arrive have at hand thin paper bags or "pokes," and weigh to within the fraction of an ounce the exact amount of Cyanide of Potassium for each separate room, as computed. On the outside of the bag write the number, letter, or name of the room for which it is intended, so there will be no mistake resulting in getting an overdose for a small room and an insufficient or underdose for a large room, by mixing the bags afterward.

To fumigate a room or building arrangements should be made before fumigation for opening the windows (after fumigating) with poles or ropes from the outside if possible, but if not possible, they should be closed but not locked. If there be large cracks they should be filled with wet paper pulp or closed by strips of paper dipped in water and laid over them with the hand, as though fastened by paste. All doors should be closed, excepting the one to be used for going out. First, newspapers, next, old pieces of carpets or other cloth should

be spread on the floor at the spots where the vessels are to stand, and upon these should be placed the vessels to contain the cyanide, acid and water.

These vessels can not be of metal, as the acid destroys metal, but should be of earthen or chinaware. It is better that they be deep rather than shallow. For example, a pitcher from a toilet set would be better than a washbowl, for the reason that a shallow vessel might permit some of the liquid to splash out by the chemical bubbling which will take place when the materials are put together, whereas the deeper vessel would prevent the splashing over, and consequently prevent injury to the carpets. The vessels to be used should be large enough to hold at least twice the amount of liquid that is to be placed in them. For example, if one pound of cyanide is to be used in a vessel, this means that it must hold two pints of sulfuric acid and four pints of water, which means a total of over six pints. Therefore, a vessel for this particular purpose should be large enough to contain twelve pints, or one and one-half gallons. This is for the purpose of preventing the splashing over at the time of fumigation, because if any liquid runs over from the vessel it is liable to injure carpets, or even run through the floor and injure and damage materials beneath. The gas itself will do no injury, but the liquid is a powerful acid, and will be liable to damage anything it touches, besides earthenware or stoneware. Of course, vessels the size of ordinary milk crocks will do very well if the poison be so divided that not more than one-half pound of cyanide and the proportionate liquids will be used in each.

The method of putting the materials together is very important. It should be remembered that it should be so arranged that the operator in charge of the work can do this quickly and leave the room immediately, because twice filling the lungs with the poisonous gas would cause him to drop over at once insensible. If the room be large enough to demand two or more vessels, these should be arranged in a row or in such plan of arrangement that it is possible to begin at the one furthest from the door and drop the cyanide into each in turn, as the operator walks toward the door through which he is to pass out. There is, of course, no danger whatever until the cyanide and sulfuric acid are placed together, when the deadly fumes will at once commence to be given off. The proper course of procedure, therefore, is to determine the amount of water that is to be placed into each vessel, measure this and pour it in. Then pour in one-half as much sulfuric acid, which will be of course, twice the amount (by fluid ounces) of cyanide of potassium (by weight) to be used. Now for each vessel weigh out the cyanide of potassium which is to go into it, and put this into a thin paper bag, and put it on the floor beside the vessel.

When all the vessels in the room have the proper amounts of sulfuric acid and water poured together therein, and the proper amounts of cyanide in bags on the floor beside each, and the windows are closed and protecting cloths under the vessels, the operator should begin at the one furthest from the door, drop the paper bag entirely and directly into the vessel containing the acid and water,—not stop to pour it in, but drop it instantly, pass to the next vessel, drop in the bag containing the cyanide, and at the next repeat the operation, continuing until all are reached, and then pass out and close the door. If there be other rooms to treat, have everything in readiness for the operation in each room. Close the doors always between each and every room where the fumigation is being done for the purpose of preventing any possible currents of air from carrying the poisonous gas from one room to another, thus reducing the efficiency of the gas in one and increasing the gas in another.

In fumigating a house the furthest or most inaccessible room should be fumigated first, and the one nearest the stairway should be fumigated last. In fumigating a building where there is an opening in the floor for a stairway and no door to close this, it is best to lay boards over this, and cover these with wet blankets to prevent the gas from the lower rooms rushing up into the upper rooms and thus diminishing the effect of the treatment below.

It should be remembered that hydrocyanic acid gas is lighter than air and consequently rises. Therefore, upper rooms should be fumigated first. It is safe to fumigate rooms and live in those that are below, but it not safe to reverse this and attempt to fumigate a lower room while living in a room above. If the wind be in the direction to carry the gas from one room toward another, it is safe to fumigate the second room or the one toward which the wind is blowing while living in the first room, or the one in the direction from which the wind comes, but this operation could not be reversed with safety. If one should attempt to fumigate a room toward the wind from one in which there is some person living, the gas might penetrate the walls to a serious extent and even be deadly in effect. However, if the unfumigated rooms be fully ventilated it would then be safe. We have seen rooms fumigated with safety with one ventilated room between the one in which the gas was generated and the one in which the family was living.

The best possible precaution for safety is to vacate the house and keep out of it for at least two hours. Household plants, cats and other pets should, of course, be removed, or they will be destroyed with the pests. The deadly effect of hydrocyanic acid gas must be impressed upon the mind of the operator. We have not found it uncommon to see English Sparrows drop dead from the top of the roofs of houses that were being fumigated, and from one mill which was fumigated

experimentally bushels of rats and mice were gathered. While this gas is powerful, deadly and instant in action, it is safe to use in the hands of any intelligent operator. It can be used in a village or city in adjoining houses, excepting where they are built in one block. In case a single room or a few rooms of a block should need fumigation, it is best to arrange to have the others on each side, as well as immediately above, ventilated by opening doors and windows during the time of fumigation of the infested room.

By following the same method it is possible to fumigate infested book cases, boxes, or trunks containing Clothes Moths or other pests, or to put woolens into comparatively small vessels and fumigate them with safety. If this be done, it will be better that it be out of doors or in an out-building.

The method of ventilation is very important for the reason that the one precaution of the operator must be to avoid breathing the deadly gas. An ordinary living room is not so large but that the operator can enter the room with perfect safety even though the gas is very strong therein, and by holding his breath go to the window and open it, and pass back out of the room and close the door before breathing again. In fact, we have seen an operator ventilate all of the upstairs rooms of a house by determining the direction from which the wind came, open one of the windows on that side for ventilation, passing to other windows or doors to open them, and always returning to this first window for breathing purposes, holding his breath during the operation in the meantime. However, even this method must be watched with care, because if a person should think it safe to merely open a window and put his head outside to breathe, he might be mistaken, because the gas from the room would have a tendency to rush out at this window, and if the air be in such direction as to carry the gas outward, he would inhale it and might drop insensible. When the air moves so as to blow into the room he is safe in breathing from an open window. Of course, large buildings, like mills and factories, should be ventilated by ropes and pulleys or poles arranged to open the windows from the outside. During such ventilation it is important that doors and windows of closely adjacent houses on the leeward or protected side be kept closed to prevent the poisonous gas from blowing into them.

The length of duration of fumigation would be at least two hours, but no danger will come from letting it remain for a much longer time or even an entire day. If it be possible to fumigate a house and go away and leave it for a few days, there will be no trouble about ventilation, because the gas will have dissipated by the time of the return of the occupants. The rooms can then be entered and ventilated in the ordinary manner.

An important point for the best results in fumigation is that the chemicals should be practically pure or not of low grade composition. The cyanide should be not less than ninety-eight per cent. pure cyanide of potassium, and if it be a low grade, especially containing common salt, it will not be nearly as efficient as it should be, and the results may be unsatisfactory. Also, the sulfuric acid should be heavy or dense, having a specific gravity of at least 1.83 degrees. Dilute or lighter specific gravity will not give as good results.

In disposing of the liquid residue in the vessels, it is important that this be not poured into metal vessels, as into sinks, bathtubs or metal pipes, unless these be immediately and abundantly flooded with water, which will carry away the acid which would immediately commence to act upon the metal with which it comes in contact. It is far better that it be poured in the gutter or some place where it is desirable to kill weeds, as it will kill any vegetation upon which it is poured.

In most cases a single fumigation will be all that is necessary to destroy insect pests of all kinds, but if the chemicals should not be of proper strength, or if the room should not be properly closed so as to be air-tight, the results may not be as good as may be desired. Also, it is known that the egg and pupal or resting stage of insects are more dormant, and thus less liable to injury by the gas than they are in the larval and adult or mature stages. Therefore, in some cases it may be necessary to repeat the fumigation in about a week or ten days, in order to kill those insects which may have successfully passed through the first fumigation in the egg stage, but which by this time will have hatched, and being in the larval or worm stage will be in their most delicate condition and easily destroyed. For further directions concerning any point not sufficiently elucidated in this article write to H. A. Surface, State Zoologist, Harrisburg, Pa.

The Cyanide, Prussic Acid or Hydrocyanic Acid Gas fumes are not inflammable nor explosive, and it is not necessary to take special care to keep fire away from them, as it would be in using Carbon Bisulphide. With these directions, published here in as great detail as we have found it necessary to observe in successful fumigation, we believe that the citizens of this and other States where this Bulletin finds circulation, should be able to enjoy freedom from household pests, at comparatively little expense, during the coming summer. It must be remembered, however, that such insects as flies will readily come again into the house unless prevented by screens, and by cleaning up the filth of stables, pig pens, poultry houses and other places in which they breed around the premises.

SPECIAL PRECAUTIONS.

Cyanide of potassium is liable to be sold in large lumps. It should be broken in smaller lumps, not larger than hickory nuts, before being used. To do this it can be placed on a stone and pounded with a hammer or hatchet, but as small pieces are liable to fly, it should be wrapped in paper or cloth to prevent their flying through the air and being lost. If they should be picked up and eaten by children, poultry or livestock, they may cause instant death. The writer had the experience of killing several chickens that ate minute fragments of cyanide of potassium that were left where larger lumps had been broken. Be sure that absolutely none is dropped or scattered. If small particles are left cover them with earth and sprinkle this with water, so that poultry will not scratch it out.

In emptying the fumigating vessels do not breathe over them any more than is necessary in carrying them out, and do not stir them or shake them up much until empty, as there is a possibility of some further gas being given off when the mixture is stirred. The liquid should not be poured into sinks where it will stand in contact with metal. If disposed of by pouring into sinks, running water should follow to wash it well out of the metal pipes. This liquid is very poisonous, and can be used to kill weeds. It will kill trees and smaller plants around which it may be poured.

It is possible to fumigate one room by keeping others open and ventilated during the process of fumigation. It is also possible to fumigate one house without danger to a solid block of others, by asking the neighbors to open their windows of the rooms adjoining it.

The same general principle and methods can be used in fumigating mills and larger buildings. The spaces between the floors should be closed, even if boards and canvass must be used to close openings temporarily. Where rooms are large as in mills, pulleys can be arranged over the jars to suspend the cyanide in bags, and lower it all at one time by strings operated from some place near the door, or several helpers can station themselves at remote places through the mill, and at a given signal, each can work toward the door, dropping the bag of cyanide into the jar of sulfuric acid and water near it, passing on from jar to jar, and in this way leaving the room together.

The fumigation methods employed by physicians for destroying disease germs, although effective for that purpose, will not be efficient in destroying insects, and, therefore, the fumigation for insect pests must not be confused with that for disease germs.

CONDENSED POINTERS.

Know how.

Be careful always.

Use no metal vessels for sulfuric acid.

Stoneware, earthen ware and granite ware should be used.

Use vessels two or three times as large as needed to hold the actual amount of liquid.

Either turn back carpets, or put padding beneath vessels for the protection of carpets and rugs.

See that the room is made air tight and everything is in readiness before commencing to fumigate.

Close all doors and windows and open places before commencing to fumigate.

Take every possible precaution to avoid inhaling the gas for a single second.

Put the water into the vessels first. Then measure in a glass graduate the amount of sulfuric acid needed, or have it measured and bottled at the drugstore, and pour this in. The fumes from this may be alarming, but as the cyanide has not been used they will not be especially dangerous. It will make some heat, but this will not be violent.

Remove living plants and pets from the room before fumigating.

Have the cyanide of potassium weighed and in small paper bags on the floor beside the vessel containing the liquid.

Where there are two or more vessels in the room, drop the cyanide into the one farthest from the door, and last into the one nearest the door, and leave the room quickly, shutting and locking the door. Make sure that no one has an opportunity to enter the room by mistake.

Let the gas remain in the room at least two hours or longer.

Be sure that no person is living in the room over the one being fumigated.

If anyone lives in an adjoining room have him open his windows and doors during the time of fumigating.

In fumigating follow directions herein given.

NURSERY INSPECTION.

A most important method of preventing the spread of noxious insects and plant diseases is found in the semi-annual inspection of the nurseries in this State. This is important directly to residents of Pennsylvania who purchase this stock and to residents of other States who buy Pennsylvania grown nursery stock.

The first inspection is begun in August and is completed in time to permit the fall shipment of stock. The second inspection is made in November and December after the leaves have fallen. These inspections are made by the Inspectors of the Division of Zoology under the direction of the Pennsylvania Department of Agriculture.

Nurserymen whose stock is found to be free from all injurious insects and diseases are granted a certificate, while this is withheld from the other nurserymen until the stock has been destroyed or fumigated according to directions. Such a procedure is a benefit to both grower and planter: the former is enabled to improve his stock, while the latter gets clean goods. Nurserymen who follow the instructions of this office are enabled to grow clean and healthy nursery stock and all progressive nurserymen are anxious to turn out the best product possible.

That the growing of nursery stock is no small business in this State is shown by the fact that there are to-day some two hundred and thirty men or firms so engaged and whose ground covers an area of upwards of three thousand eight hundred acres.

Below is found a list of the nurseries inspected and licensed in the State of Pennsylvania, giving the name of owner or manager, address, area involved, and certificate number of each:

LIST OF PENNSYLVANIA NURSERYMEN WHO HAVE BEEN GRANTED CERTIFICATES FOR THE YEAR ENDING AUGUST 31, 1913.

		Number of acres.	Certificate Number.
ADAMS COUNTY.			
Taylor & Heckenluber,	Biglerille,	1	B-158
W. W. Boyer & Bro.,	Arendtsville,	24	B-173
H. G. Baugher, Propr., The Adams Co. Nursery,	Aspers,	30	B-133
C. A. Stoner,	Gettysburg,	9	B-16
H. R. Plank,	York Springs,	3	1975
Cornelius Bender, R. D. No. 2,	Aspers,	1	1974
C. A. Hartman,	Cashtown,	2	1977
Geo. Oyler,	Gettysburg,	6	1978
J. C. Carey, R. D. No. 5,	Gettysburg,	3	B-135
J. L. Kane, R. D. No. 5,	Gettysburg,	1	B-124
E. F. Strausbaugh,	Orrtanna,	4	B-149
David I. Weaver, R. D. No. 5,	Gettysburg,	1	1976
A. D. Taylor,	Biglerville,	1	.....
Tyson Bros.,	Floradale,	2	B-150
Musselman Canning Co.,	Biglerville,	1	B-157
C. J. Tyson, Mgr.,	Flora Dale,	2	B-167
ALLEGHENY COUNTY.			
Elliot Nursery Co.,	Springdale,	30	B-105
August G. Espe, R. D. No. 1,	Perryville,	4	1984
McRae-Jenkinson Co.,	Cheswick,	4	B-152

*Grow berry or small fruit plants only.

		Number of acres.	Certificate Number.
BEAVER COUNTY.			
James W. Mackall,	Beaver,	6	B-132
R. C. Mackall,	Beaver,	6	B-136
Mary E. Goodwin, Administratrix,	Industry,	1	B-50
*J. D. Arnold & Bro.,	Beaver Falls,	5	B-55
*A. J. Freed,	Racine,	2	B-52
S. H. Caven & Sons,	Beaver Falls,	3	B-54
*J. M. Hoyt,	Industry,	7	B-51
BEDFORD COUNTY.			
Austin Wright,	Alum Bank,	1	B-27
BERKS COUNTY.			
Bertrand H. Farr,	Wyomissing,	10	B-117
BLAIR COUNTY.			
Geo. S. Burket,	Claysburg,	1	1965
BRADFORD COUNTY.			
Fred W. Card,	Sylvania,	1	B-90
BUTLER COUNTY.			
Harmony Nursery Co.,	Evans City,	4	B-164
Jas. R. Pierce,	Butler,	5	1986
BUCKS COUNTY.			
J. L. Lovett,	Emile,	5	B-126
Henry Palmer,	Langhorne,	4	B-14
Horace Jannney,	Newtown,	7	B-15
D. Landreth Seed Co.,	Bristol,	2	B-7
The Wm. H. Moon Co.,	Morrisville,	400	B-73
Morrisville Nurseries,	Morrisville,	40	1953
M. A. Youngken,	Richlandtown,	1	B-59
Jacob F. Krout, R. D. No. 1,	Perkasie,	2	B-83
Penna. R. R. Co., Forestry Department, John Foley,	Morrisville,	83	B-78
Forester, Philadelphia, Pa. Nursery near,	Kintnersville,	1	B-137
S. R. Trach,			
CENTRE COUNTY.			
State College, Department of Horticulture, W. B. Nissley, Mgr.,	State College,	1	B-146
CHESTER COUNTY.			
James Donoghue,	Kennett Square,	24	1899
W. H. Doyle,	Berwyn,	10	B-32
The Morris Nursery Co.,	West Chester,	200	B-66
The Conard & Jones Co.,	West Grove,	35	1989
The Dingee & Conrad Co.,	West Grove,	7	1990
The Rakestraw Pyle Co.,	Kennett Square,	200	B-67
J. A. Roberts,	Malvern,	20	B-116
Hoopes Bro. & Thomas Co.,	West Chester,	650	B-47
J. B. Relf,	Spring City,	3	B-127
E. B. Keating,	Kennett Square,	1	B-133
Louis B. Eastburn,	Kennett Square,	5	B-139
E. W. Twaddell,	Westtown,	2	B-115
H. H. Corson & Son,	Avondale,	1	B-140
Milton Clevenstine,	Kimberton,	13	B-120
*A. W. Van Tassel,	Kennett Square,	11	B-165
CLEARFIELD COUNTY.			
W. S. Wright,	Clearfield,	1	B-46
COLUMBIA COUNTY.			
Philip Harris, R. F. D.,	Light Street,	1	1997
T. D. Robbins,	Light Street,	1	1998
Frank Harris,	Light Street,	1	B-1
CRAWFORD COUNTY.			
*David Kely,	Cochranston,	11	B-28
*Bailey Bros., R. D. No. 66,	Cochranston,	14	1992
*Henry Roberts, R. D. No. 66,	Cochranston,	7	B-30
*Lewis E. Swogger, R. D. No. 28,	Carlton,	1	B-21
*J. O. Marsh,	Geneva,	8	B-35
*Fred Schaffner, R. D. No. 2,	Meadville,	11	B-34
*D. H. Lefever, R. D. No. 2,	Meadville,	1	B-61

*Grow berry or small fruit plants only.

		Number of acres.	Certificate Number.
CUMBERLAND COUNTY.			
B. F. Cocklin, R. D. No. 2,	Mechanicsburg,	12	B-106
R. A. Wickersham,	Mechanicsburg,	50	B-113
DAUPHIN COUNTY.			
*M. S. Brinser,	Middletown,	2	1947
The Berryhill Nursery Co.,	Harrisburg,	25	B-80
C. P. Scholl, R. D. No. 1,	Halifax,	24	1945
*Andrew Coble, R. D. No. 1,	Middletown,	4	1946
C. B. Landis,	Penbrook,	4	1944
T. A. Woods,	Harrisburg,	1	B-147
*Theodore Burris,	Royalton,	1	1919
*Edward W. Creep, 460 Spruce St.,	Middletown,	1	1943
*David Z. Miller, R. D. No. 2,	Middletown,	1	B-161
DELAWARE COUNTY.			
F. Z. Supplee & Son,	Collingdale,	20	B-12
J. J. Styer,	Concordville,	2	B-13
M. J. Porter,	Wayne,	2	B-3
C. H. Pettiford,	Lansdowne,	1	B-9
W. E. Caum (Lessee),	Haerford,	4	1905
John G. Gardner,	Bryn Mawr,	7	B-11
H. H. Battles,	Newtown Square,	10	B-10
Otto Lachman,	Wallingford,	2	B-104
ERIE COUNTY.			
*Harry Youngs, R. D. No. 2,	North East,	24	B-43
*M. E. Geer,	Girard,	2	B-62
Penna. Nursery Co.,	Girard,	75	B-1283
L. C. Hall,	Avonia,	1	B-60
*A. F. Youngs, R. D. No. 2,	North East,	1	B-41
*Orton Bros.,	North East,	1	B-33
L. G. Youngs,	North East,	4	B-42
*W. E. Smith, R. D. No. 2,	North East,	24	B-39
Erie Floral Co.,	Erie,	1	B-144
*F. G. Mohring,	North Girard,	5	B-65
*J. N. Meader,	North Girard,	5	B-64
*Leon D. Moore,	Corry,	24	B-32
Emil Laurent,	Girard,	1	B-151
*J. G. Bagley, R. D. No. 3,	North East,	1	B-44
*W. S. Waldo,	North Girard,	1	B-63
*Perry Goodrich,	North East,	2	B-36
*F. K. Taber,	North East,	1	B-37
Stark Bros. Nurseries and Orchards Co.,	North Girard,	100	1991
Lake Shore Nurseries,	Girard,	10	B-159
H. S. Loop,	North East,	1	B-163
FRANKLIN COUNTY.			
Penna. Department of Forestry, Prof. E. A. Zeigler, (Forester), Mont Alto Nursery,	Mont Alto,	3	B-123
Henry Elcholz,	Waynesboro,	1	B-122
Penna. Department of Forestry, Robt. G. Conklin, (Forester), Caledonia Nursery,	Fayetteville,	1	B-124
Mira L. Dock,	Fayetteville,	1	B-121
Byer Bros. (Florists),	Chambersburg,	1	B-143
FULTON COUNTY.			
*Frank P. Flessinger,	Locust Grove,	1	B-153
GREENE COUNTY.			
Perry M. Rush,	Sycamore,	1	1985
JUNIATA COUNTY.			
*John K. Oberholtzer,	Mifflintown,	2	1972
*S. H. Graybill,	Richfield,	5	1971
*Wm. Banks,	Mifflintown,	9	1970
*John H. Shellenberger,	McAllisterville,	8	1968
C. S. Winey,	McAllisterville,	2	1963
*C. G. Pellman,	Richfield,	3	1967
*Edward Rupert,	McAllisterville,	2	1966
LACKAWANNA COUNTY.			
*Elmer B. Richards,	Baldmount,	1	B-97
John W. Shephard, 945 Clay Ave.,	Scranton,	4	B-119
Daniel O'Hara,	Dunmore,	1	B-96

*Grow berry or small fruit plants only.

	Number of acres.	Certificate Number.
LANCASTER COUNTY.		
John G. Engle,	1	B-142
Maurice P. Brinton,	6	B-1983
W. B. Bolton,	5	B-108
Wilson Kready,	15	B-69
O. W. Laushey,	4	B-1881
A. W. Root & Bro., R. D. No. 1,	22	B-1594
David S. Herr, R. D. No. 7,	10	B-1908
M. H. Munser,	23	B-1932
B. F. Barr & Co.,	20	B-107
Frank A. Suter,	1	B-1987
John G. Rush,	12	B-1979
Geo. W. Park (Florist),	1	Special
LAWRENCE COUNTY.		
Butz Bros.,	1	B-58
A. S. Moore,	1	B-56
LEHIGH COUNTY.		
Lehigh Nurseries,	1	B-113
*Preston J. Klique,	3	B-88
LUZERNE COUNTY.		
Miss M. A. Maffett,	1	B-84
F. B. Wheeler,	1	B-125
Warren E. Straw,	1	B-98
R. S. Barry,		Special
Keystone Strawberry Co.,	11	B-156
MERCER COUNTY.		
*H. H. McClearn,	2	B-18
*D. C. McClearn,	1	B-26
*Geo. W. Proud,	2	B-20
*W. M. Doyle,	7	B-25
*Robert Doyle,	4	B-24
*Geo. F. Brocklehurst, R. D. No. 20,	3	B-23
*J. T. McLean, R. D. No. 16,	1	B-1848
J. L. Hoobler & Son, R. D. No. 31,	1	B-33
W. R. Cribbs,	1	B-69
*J. E. Brocklehurst,	1	B-19
Hugh Hogue, R. D.,	2	B-23
E. Meade Gibson,	1	B-53
*J. N. Hughes,	2	B-67
*William Ride,	1	B-29
MIFFLIN COUNTY.		
Penna. Department of Forestry, Tom O. Brietsch (For- ester), Nursery and Forest Reservation near Green- wood, Huntingdon Co., Pa.,	2	B-48
MONTGOMERY COUNTY.		
Christ Koehler,	2	B-79
R. B. Haines Co.,	10	B-119
J. B. Heckler,	4	B-131
J. W. Thomas & Sons,	90	B-136
J. Krewson & Sons,	30	B-68
J. B. Moore,	5	B-109
Adolph Mueller,	15	B-118
Thomas Meehan & Sons,	225	B-75
Wm. Sturzebecker,	2	B-111
Edward D. Drown,	1	B-81
J. G. Steffen,	6	B-110
Somerton Nurseries, A. U. Bannard, Mgr., 125 So. 5th St., Philadelphia,	20	B-92
A. E. Wohler,	10	B-128
Alexander Cummings & Son,	5	B-130
Pa. School of Horticulture for Women,	1	B-162
MONROE COUNTY.		
E. M. Werkelsen, Forest Plants and Seedlings,		Special
W. K. La Bar, Forest Plants and Seedlings,		Special
NORTHAMPTON COUNTY.		
Theodore Roth,	1	B-85
Hays Nursery Co.,	1	B-87
Easton Cemetery Co.,	1	B-86
NORTHUMBERLAND COUNTY.		
*Francis W. Peifer, R. F. D.,	1	B-94
S. L. Cummings,	1	2000

*Grow berry or small fruit plants only.

		Number of acres.	Certificate Number.
PERRY COUNTY.			
Geo. A. Wagner, R. F. D.,	Landisburg,	2	B-141
*Robert Kretzler, R. F. D. No. 1,	Liverpool,	1	1999
PHILADELPHIA COUNTY.			
W. W. Harper,	Chestnut Hill,	650	1952
Thos. Meehan & Sons, Inc.,	Germantown,	60	B-74
T. N. Yates & Co.,	Mt. Airy,	6	B-103
John B. Lewis,	Bustleton,	5	B-71
A. F. O'Connell, Overbrook,	Philadelphia,	65	B-72
John Stephenson's Son,	Oak Lane,	2	B-70
Phila. & Reading R. R. Co., Nursery at Wayne Junc.,	Philadelphia,	1	B-91
W. Atlee Burpee & Co. (Special),	Philadelphia,	1	B-155
POTTER COUNTY.			
M. L. Benn,	Coudersport,	11	B-77
SNYDER COUNTY.			
*T. G. Arbogast,	Swineford,	4	1962
*John F. Boyer, R. F. D. No. 4,	Middleburg,	10	1958
*Philip A. Apple, R. F. D.,	Middleburg,	1	1957
*Fred G. Moyer,	Freeburg,	1	1956
*A. W. Rohrer,	McKees Half Falls,	11	1960
F. L. Hancock,	Port Trevorton,	1	1964
*Moyer & Wilt,	Freeburg,	1	1955
*A. S. Sechrist,	Port Trevorton,	1	B-154
*Geo. W. Reichenbach,	Mt. Pleasant Mills,	1	1963
*E. A. Shafer,	Port Trevorton,	21	1961
*Philip T. Moyer,	Freeburg,	1	1954
*E. S. Stauffer,	Port Trevorton,	11	1959
*Geo. W. Beaver,	Middleburg,	3	B-3
*John H. Moyer,	Swineford,	3	B-4
*Geo. W. Dreese,	Mt. Pleasant Mills,	21	B-6
SOMERSET COUNTY.			
H. E. Purbaugh,	Harnedsville,	1	B-45
SUSQUEHANNA COUNTY.			
*E. A. Smith,	Heart Lake,	8	B-95
*Geo. P. Sprout, R. F. D. No. 66,	Montrose,	6	B-96
TIOGA COUNTY.			
Arthur Edwards,	Elkland,	1	B-100
*Homer B. Howe,	Wellsboro,	21	B-102
Penna. Department of Forestry, Paul H. Mulford, Forester,	Asaph,	13	B-101
UNION COUNTY.			
C. K. Sober (Nursery near Paxinos, Northumberland Co.),	Lewisburg,	25	B-5
VENANGO COUNTY.			
Venango Nursery Co., R. F. D. No. 1,	Franklin,	1	1993
WARREN COUNTY.			
D. D. Hamblin,	Youngsville,	2	B-31
*Geo. W. Wood,	Spring Creek,	1	B-40
WESTMORELAND COUNTY.			
John McAdams,	Mt. Pleasant,	1	B-49
WYOMING COUNTY.			
*F. H. Fassett,	Meshoppen,	11	B-112
*H. S. Hitchcock,	Laceyville,	1	B-2
*W. E. Shoemaker,	Laceyville,	7	B-114
*W. N. Lutes,	Beaumont,	31	B-99
YOIRK COUNTY.			
Patterson Nursery Co.,	Stewartstown,	25	B-145
Geo. E. Stein,	East Prospect,	6	1951
W. S. Newcomer,	Glenrock,	41	1960
F. E. Cremer,	Hanover,	1	B-17
Philip M. Craley,	Red Lion,	1	B-160

*Grow berry or small fruit plants only.

PENNSYLVANIA TREE DEALERS.

The tree dealer is defined as a person who purchases trees from different sources and sells them upon his own responsibility and does not act as an agent for any one nursery. He differs from an agent in that the latter directly represents his firm. Thus contracts made by an agent, who is a representative of the firm, binds the firm. For this reason an agent is not required to have a certificate. The tree dealer, however, must have a certificate in order to transact business legally in Pennsylvania.

The government of the several States together with the Federal government are ever vigilant to prevent the spread of dangerous insects and plant diseases. In Pennsylvania one feature of this is found in the fact that tree dealers are required to have a certificate in order to transact business. As shown above, the tree dealer buys his trees from a number of sources,—within or without this State. Nurserymen in Pennsylvania have their stock inspected every year and if it is found satisfactory, a certificate of inspection is granted. Dealers outside the State of Pennsylvania who contemplate shipping their stock into this State, file each year an affidavit of fumigation. In turn their nurseries are inspected by their State Inspector just as are our nurseries. Any tree dealer, then, can obtain a certificate by writing to this office and giving a list of the nurserymen from whom he expects to buy his stock; one or more firms may be included. Certificate is then granted to the tree dealer if investigation shows that the parties from whom he buys are properly certified and doing a legitimate business, and the dealer agrees to buy from these firms only. This is a just measure which serves to help prevent the spread of noxious insects and plant diseases.

The following is a list of the certified tree dealers in the State of Pennsylvania, revised to March 1, 1913:

AGENTS AND DEALERS FOR THE YEAR ENDING JULY 31, 1913.

		No. of certificate.
ALLEGHENY COUNTY.		
John Bader Co.,	Pittsburgh,	715
H. M. Devereaux,	Avalon,	677
W. B. Bockstose,	Castle Shannon,	682
L. F. Miller, 1023 Gerret St.,	Pittsburgh,	639
E. O. Hauser,	Emsworth,	636
Charles Honess & Son, 719 Fulton St.,	Allegheny,	633
J. F. Zimmerman,	Pittsburgh,	706
Mark E. Head, 230 Rodgers Ave.,	Bellevue,	665
Kauffman Bros.,	Pittsburgh,	650
Jos. Herne Co.,	Pittsburgh,	709
A. W. Graper, 103 Diamond Market,	Pittsburgh,	670
K. B. Jones, 537 Penn Ave.,	Pittsburgh,	708
A. W. Smith Co. (Keenan Building),	Pittsburgh,	713
ARMSTRONG COUNTY.		
B. E. Long, R. F. D. No. 1,	Dayton,	716
BEAVER COUNTY.		
J. O. Withrow,	Vanport,	651
J. H. Gutermuth,	Rochester,	649
A. E. Crouch,	Rochester,	635
BEDFORD COUNTY.		
W. D. Slick,	New Paris,	703
BERKS COUNTY.		
M. E. Smeltzer, 131 W. Greenwich St.,	Reading,	671
Alfred S. Dreibelbis,	Reading,	637
W. H. McKinney, R. F. D. No. 1,	Sinking Springs,	702
BLAIR COUNTY.		
E. J. Whitbread,	Altoona,	723
Allen S. Myers,	Eldorado,	631
E. C. Moller,	Lakemont,	730
BUCKS COUNTY.		
John F. Barclay, R. F. D. No. 2,	Doylestown,	706
Quakertown Plant Co., C. E. Bartholomew, Prop'r,	Quakertown,	634
BUTLER COUNTY.		
W. C. Riddle,	Slippery Rock,	712
Geo. W. Haine,	Evans City,	653
CARBON COUNTY.		
Paul Neihoff,	Lehighton,	673
David N. Rehr,	Lehighton,	676
CHESTER COUNTY.		
John Alcorn,	Malvern,	649
CLEARFIELD COUNTY.		
Thos. W. Munro,	Du Bois,	659
Wm. G. Jones,	Du Bois,	731
CLINTON COUNTY.		
W. W. Richie,	Lock Haven,	641
CRAWFORD COUNTY.		
J. A. Knapp,	Meadville,	645
B. D. Maynard,	Saegertown,	719
J. C. Boyd,	Guy's Mills,	660
A. B. Greenfield & Sons,	Conneautville,	646
J. B. Long,	Harmonsburg,	661
E. A. Beebe,	Conneautville,	711
Geo. W. Breese,	Conneautville,	632

		No. of certificate.
CUMBERLAND COUNTY.		
Ira E. Bigler,	Camp Hill,	685
D. C. Rupp,	Shiremanstown,	629
Towzer & Son,	Carlisle,	680
D. F. Haskell,	Carlisle,	627
DAUPHIN COUNTY.		
A. H. Shreiner, 1614 Forster St.,	Harrisburg,	679
Geo. F. Greenawalt,	Hummelstown,	639
T. A. Woods,	Harrisburg, .....	...
J. R. Snively, 125 Liberty St.,	Harrisburg,	725
Holmes Seed Co.,	Harrisburg,	726
DELAWARE COUNTY.		
John Wetherill,	Chester,	718
ERIE COUNTY.		
Wm. Keefe & Son,	Erie,	646
C. J. Roberts,	Albion,	637
H. C. Pettis,	Platea,	706
C. F. Amidon,	North East,	666
FAYETTE COUNTY.		
Keystone Florist and Seed Co., Edwin Sellers, Mgr.,	Connellsville,	722
FRANKLIN COUNTY.		
H. C. Ely,	Waynesboro,	698
J. W. Hemfening,	Greenvillage,	692
W. E. Niswander, R. F. D. No. 1,	Mason and Dixon,	634
FULTON COUNTY.		
Geo. W. Sipe,	Harrisonville,	707
LACKAWANNA COUNTY.		
G. R. Clark, 124 Washington Ave.,	Scranton,	664
Giles L. Clark, 300 Wood St.,	Scranton,	673
A. J. Noble, 723 Columbia Ave.,	Scranton,	676
LANCASTER COUNTY.		
Amos D. Herr, 510 W. Orange St.,	Lancaster,	631
Daniel G. Engle,	Marletta,	662
LEBANON COUNTY.		
Samuel P. Moyer,	Myerstown,	719
M. D. M. Batdorf,	Richland,	654
LEHIGH COUNTY.		
Melchoir Werkheiser,	Allentown,	714
Samuel I. Leh,	Allentown,	672
LUZERNE COUNTY.		
Bernard M. Rifkin,	Wilkes-Barre,	632
F. B. Wheeler,	Wyoming,	674
J. D. Anderson,	Laketon,	666
A. E. Bonsey & Co.,	Dorrancton,	724
LYCOMING COUNTY.		
Evenden Bros.,	Williamsport,	727
McKEAN COUNTY.		
F. S. Palmer,	Bradford,	638
MERCER COUNTY.		
G. Meade Gibson,	Mercer,	701
MONROE COUNTY.		
L. D. Milenberger,	M. Stroudsburg,	662
S. P. Smiley, 311 N. 8th St.,	Stroudsburg,	644
Harvey Milenberger,	E. Stroudsburg,	704

		No. of certificate.
MONTGOMERY COUNTY.		
Geo. Shoettle,	Norristown,	717
Wm. H. Hiestand,	Pottstown,	633
NORTHAMPTON COUNTY.		
Dominico Sebastino,	Roseto,	683
NORTHUMBERLAND COUNTY.		
H. F. Frank,	Montandon,	665
L. W. Foust, R. F. D. No. 3,	Watsonstown,	647
PHILADELPHIA COUNTY.		
Moore Seed Co.,	Philadelphia,	668
J. R. Giffen, 5341 Webster St.,	Philadelphia,	686
Wm. Henry Maule,	Philadelphia,	6
Henry F. Michel Co.,	Philadelphia,	657
Johnson Seed Co., 217 Market St.,	Philadelphia,	648
Hosea Waterer, 107 S. 7th St.,	Philadelphia,	637
Lit Bros.,	Philadelphia,	720
John Wanamaker,	Philadelphia,	643
SCHUYLKILL COUNTY.		
W. O. Snyder,	Minersville,	696
TIOGA COUNTY.		
E. H. Wheaton,	Knoxville,	731
Arthur Edwards,	Elkland,	681
UNION COUNTY.		
J. G. Oberdorf, R. F. D. No. 2,	Millinburg,	658
VENANGO COUNTY.		
Bell Floral Co.,	Franklin,	694
WYOMING COUNTY.		
E. A. Ney,	Eatonville,	667
YORK COUNTY.		
J. H. Painter, 705 W. Philadelphia St.,	York,	642
Henry M. Everhart,	Manchester,	722
D. C. Kauffman, 85 W. Philadelphia St.,	York,	630
E. J. Weiser, R. D. No. 11,	York,	720
OHIO.		
Jones & Vernon,	Troy, Miami Co., Ohio, ..	680
Myers Bros. & Co.,	Willmot, Stark Co., Ohio, ..	678

**NURSERYMEN FROM OTHER STATES WHO HAVE FILED
AFFIDAVITS OF FUMIGATION WITH THIS DEPARTMENT,
VALID TO AUGUST 31, 1913.**

As the nursery inspection law of this State requires the fumigation of nursery stock consigned to Pennsylvania from other States, we give herewith a list of nurserymen who have filed in this office affidavits for the year ending August 31, 1913.

As this list includes most of the leading nurserymen in other States who ship into Pennsylvania we suggest that planters and nurserymen in this State in ordering stock confine themselves to the list as given herewith. By the affidavits filed with us they obligate themselves to fumigate such stock as is liable to infestation by San Jose Scale, not including florists greenhouse plants and flowers of varieties not attacked by San Jose Scale, nor other injurious insects or diseases, nor ornamental trees and shrubs not liable to infestation by San Jose Scale and liable to injury by fumigation.

ALABAMA.

Chase Nursery Co.,Huntsville
Huntsville Wholesale Nurseries,Huntsville
Oak Lawn Nursery, A. W. Newson, Mgr.,Huntsville

CONNECTICUT.

Barnes Bros. Nursery Co.,Yalesville
Burr Nurseries, C. R. Burr, Mgr.,Manchester
Stephen Hoyts Sons Co.,New Canaan

DELAWARE.

Delaware Nurseries, D. S. Collins, Mgr.,Milford
Dover Nurseries, G. D. Jackson, Prop.,Dover
D. S. Myer & Son,Bridgeville

FLORIDA.

The Griffing Bros. Co.,Jacksonville

GEORGIA.

P. J. Berckmans Co. Fruitland Nurseries,Augusta
Otto Katzenstein & Co.,Atlanta
A. C. Oelschig & Sons,Savannah

ILLINOIS.

American Horticultural Co.,Chicago
Arthur Bryant & Son,Princeton
Robert Douglas' Sons,Waukegan

D. Hill Nursery Co.,	Dundee
Swain Nelson & Sons Co.,	Chicago
Peterson Nursery, 108 La Salle St.,	Chicago
Vaughan's Seed Store, 84 Randolph St.,	Chicago

INDIANA.

C. M. Hobbs & Sons,	Bridgeport
Knox Nurseries, H. M. Simpson, Secretary,	Vincennes

IOWA.

Mount Arbor Nurseries, E. S. Welch, Prop.,	Shenandoah
The Gardner Nursery Co.,	Osage
D. S. Lake,	Shenandoah

KANSAS.

The Winfield Nurseries,	Winfield
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KENTUCKY.

The Donaldson Co., Willadean Nursery,	Sparta
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MARYLAND.

The Franklin Davis Nursery Co.,	Baltimore
Fleming & Hetzer (The Mountain View Nursery Co.),	Williamsport
Grier Bros.,	Forest Hill
J. G. Harrison & Sons,	Berlin
J. E. Stoner, Westminster Nurseries,	Westminster
J. W. Jones & Son,	Allen

MASSACHUSETTS.

J. W. Adams & Co.,	Springfield
The Bay State Nurseries, W. H. Wyman, Prop.,	North Abington
W. F. Cobb,	Franklin
Eastern Nurseries, H. S. Dawson, Mgr.,	Jamaica Plain
Framingham Nurseries, W. H. Wyman, Prop.,	Abington
New England Nurseries,	Bedford
The Reading Nurseries, J. Woodward Manning,	Reading
The Floramead Nursery, J. Woodward Manning,	North Wilmington

MICHIGAN.

The Greening Nursery Co.,	Monroe
Kalamazoo Nurseries,	Kalamazoo
I. E. Ilgenfritz Sons Co.,	Monroe
Michigan Nursery Co.,	Monroe

MISSOURI.

Stark Bros., Nurseries & Orchards Co.,	Louisiana
Wild Bros., Nursery Co.,	Sarcoile

NEBRASKA.

German Nurseries, Carl Sonderegger, Prop.,	Beatrice
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NEW JERSEY.

Wm. F. Basset Nurseries, The,	Hammonton
Charles Black,	Highstown
Jos. H. Black Son & Co.,	Highstown
Bobbink & Atkins,	Rutherford
Arthur J. Collins,	Moorestown
Henry A. Dreer,	Riverton
Elizabeth Nurseries,	Elizabeth
F. & F. Nurseries,	Springfield
Peter Henderson & Co. (Office 35 Cortland St., N. Y.),	Jersey City
Hiram T. Jones,	Elizabeth
J. T. Lovett,	Little Silver
North Jersey Nurseries,	Milburn
C. Ribsam,	Trenton
Geo. A. Schultz,	Jamesburg
T. E. Steele,	Palmyra
West Jersey Nurseries, Stanton B. Cole, Prop.,	Bridgeton

NEW YORK.

Allen Nursery Co.,	Rochester
Arcadia Rose Co.,	Newark
Edward Bacon,	Dansville
Bloodgood Nurseries,	Flushing
H. M. Blowers,	Westfield
Nelson Bogue,	Batavia
Brown Bros. Co.,	Rochester
Wm. D. Burt,	Dalton
John Charlton & Sons,	Rochester
Chase Bros. Nursery Co.,	Rochester
Clark Nursery Co., The,	Waterloo
Chas. H. Chase,	Rochester
Charlton Nursery Co., The,	Rochester
Chase Nurseries,	Geneva
Charles J. Chism,	Rochester
G. A. Costich Co.,	Rochester
Sepharine Costich,	Irondequoit
Dansville Fruit Tree Co.,	Dansville
Denton, Williams & Denton,	Dansville
Ellwanger & Barry,	Rochester
Emmons & Co.,	Newark
Empire State Nursery Co.,	Waterloo
Fairview Nurseries, The,	Irondequoit
John W. Finn,	Dansville
First National Nurseries,	Rochester
Fruit Growers' Nurseries, P. M. Bush, Supt.,	Newark
R. B. Griffith,	Fredonia
Fruitland Nurseries, The,	Rochester
Genessee alley Nurseries, The,	Rochester
Glen Brothers,	Rochester
Graham Nursery Co.,	Rochester
Green's Nursery Co.,	Rochester
L. W. Hall & Co., (Eagle Nurseries),	Rochester
M. H. Harmon Co., The,	Geneva

Hawks Nursery Co., The,	Rochester
Herrick Seed Co.,	Rochester
D. H. Henry,	Geneva
Henry P. Hill,	Penfield
Home Planters' Association, The, H. B. Phillips, Sec'y.,	Rochester
Hooker, Wyman & Co.,	Rochester
Jackson & Perkins Co.,	Newark
Josselyn Nursery Co., The,	Fredonia
T. S. Hubbard Co.,	Fredonia
Kelly Bros.,	Dansville
King Bros.,	Dansville
Knight & Bostwick,	Newark
La Pointe Nursery Co.,	Geneva
P. McDonnell & Son,	Geneva
McGlennon & Kirby,	Rochester
Maloney Bros. and Wells,	Dansville
Thos. J. Maney,	Geneva
H. E. Merrill Nursery Co.,	Geneva
E. Moody & Sons,	Lockport
J. B. Money, Nurseries, The,	Dansville
Moore & Co., Wm. C.,	Newark
Morey & Son,	Dansville
Ontario Nursery Co.,	Geneva
Orleans Nurseries, The,	Fort Plain
Pan-American Nurseries,	Rochester
Robt. J. Peck,	Penn Yan
Perry Nurseries,	Rochester
Protective Nurseries, The,	Geneva
Alton E. Randall,	Dansville
F. Augustus Reddy, Monroe Co. Nurseries,	Rochester
Reilly Bros.,	Dansville
Wm. J. Reilly,	Dansville
Rice Bros. Co.,	Geneva
T. W. Rice,	Geneva
Rich Land Nurseries,	Rochester
Lewis Roesch & Son,	Fredonia
Rupert & Son, W. P.,	Seneca
W. A. Salter,	Rochester
F. E. Schifferli,	Fredonia
Sheerins' Wholesale Nurseries,	Dansville
Emler Sherwood,	Odessa
W. & T. Smith Co.,	Geneva
Geo. C. Stone,	Dansville
George A. Sweet,	Dansville
H. S. Taylor Co.,	Rochester
E. C. & V. L. Tiger,	Patchogue
G. Trautman, Jr.,	Geneva
Universal Nurseries, Thos. J. Bolger, Prop.,	Geneva
Van Dusen Nurseries, The, W. L. McKay, Prop.,	Geneva
James Vicks' Sons,	Rochester
W. S. Waldo Nursery Co.,	Rochester
Wells Wholesale Nursery,	Dansville
Western New York Nursery Co.,	Rochester
S. D. Willard,	Geneva
Willett & Wheelock,	North Collins

Allen L. Wood, Woodland Nurseries,	Rochester
H. S. Willey & Son,	Cayuga
E. M. Wright,	Geneva

NORTH CAROLINA.

Biltmore Nursery, C. D. Beadle, Mgr.,	Biltmore
Valdesian Nurseries, Geo. W. Jones, Mgr.,	Bostic
J. Van Lindley Nursery Co.,	Pomona

OHIO.

American Rose & Plant Co.,	Springfield
W. A. Allen & Sons,	Geneva
Baird & Brady,	Troy
M. Barnes & Co., Station K,	Cincinnati
A. Barnes & Son,	Mt. Healthy
M. F. Barnes,	Hamilton
A. F. Bernard, Rosemont Nursery,	Painesville
Peter Bohlender & Sons, Spring Hill Nurseries,	Tippecanoe City
N. Buechly,	Clayton
S. W. Call,	Perry
M. L. Carr's Sons,	Yellow Springs
H. J. Champion & Sons,	Perry
Climax Nursery Co., W. K. Martin, Prop.,	Horatio
W. B. Cole,	Painesville
Cope Bros.,	Salem
Crest Nursery,	Piqua
Fairmount Nursery Co., The, C. F. Reece, Mgr.,	Troy
Ernst Nurseries, Chas. Ernst, Prop.,	Moscow
Farmers' Nursery Co., S. R. Fergus, Prest.,	Troy
French Nursery, The,	Clyde
R. A. Hacker,	Painesville
W. W. Joiner,	Perry
Henry Kohankie & Son,	Painesville
Martin Kohankie,	Painesville
McNary & Gaines, Xenia Star Nursery,	Xenia
Merriman & Salkeld,	Perry
Miami Valley Nurseries,	Tippecanoe City
W. L. Musselman,	New Carlisle
T. R. Norman,	Painesville
Ohio Nursery & Supply Co., W. P. Bates, Mgr.,	Elyria
G. S. Pickett & Son,	Clyde
Geo. H. Poe, Poe's Vineyard,	Kenton
The Progress Nursery,	Troy
M. O. Ressler, Lima Nursery Co.,	Lima
W. N. Scarff,	New Carlisle
The Schmidt & Botley Co.,	Springfield
Storrs & Harrison Co., The,	Painesville
Thé Wagner Park Conservatory,	Sidney
Mark Welch,	Painesville
T. B. West, Maple Bend Nursery,	Perry

RHODE ISLAND.

Daniel A. Clarke,	Fiskeville
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TENNESSEE.

J. C. Hale Nursery Co., TheWinchester
 Southern Nursery Co.,Winchester

VIRGINIA.

W. T. Hood & Co.,Richmond
 F. D. Green,Farmville

WISCONSIN.

Evergreen Nursery Co.,Sturgeon Bay

 REPORT OF INSPECTION OF GREEN HOUSES.

During the year this Department was informed by the U. S. authorities that by the rulings of the U. S. Postal Department it was necessary that all green house stock to be mailed should be inspected and be certified by a tag attached to it stating that it had been inspected and was free from injurious pests, before it could be sent through the mail. This necessitated a considerable amount of extra work for this office, and the expense was also proportionately increased. However, we sent inspectors to the green houses requesting this service growing plants of any kind for mail shipment, and helped them in every way possible to send out clean stock.

As a rule the green houses in this State were found remarkably free from serious pests, yet the Federal requirement of inspection demanded that this work be done, and in order that our citizens could take advantage of the parcel post law and send by mail, we voluntarily inspected all green houses doing mail order business in this State requesting this service.

The chief pests of green houses as found at present in this State are as follows: Aphids or plant lice, Mealy bugs, Soft Scale or Palm Scale, White Fly, Ants, Nematodes or Root worms and Sow bugs or Pill bugs. Of course, other species may be found occasionally and yet others are liable to be introduced into this State at any time.

It should be remembered that it is against the law to send by mail any plant that is not inspected and accompanied by a certificate of inspection and apparently free from dangerous diseases or insect pests. This ruling is broad enough to include garden plants such as cabbage, sweet potatoes, peppers, etc., and for the purpose of coming under the inspection requirement of the U. S. Postal Department, it becomes necessary to regard such plants as green house stock and to

have them rightly inspected and certified by the Department of Agriculture before they are mailable matter. Inspection service is rendered free of charge by this office, but it becomes quite a burden in view of the extra expense of travel; if those persons requiring the service do not communicate with us promptly and give us opportunity to arrange a circuit or an itinerary in such a way as to reach several persons at one trip. Therefore, it is important that all persons needing green house inspection service in order to permit them to mail plants of any kind should notify us at least thirty days in advance of the time when they will find they need the copy of the official certificate to attach to their packages for mailing.

Special articles or bulletins discussing the pests mentioned above as our chief green house pests may be obtained free of charge by addressing H. A. Surface, Economic Zoologist, Harrisburg, Pa.

INSPECTION OF IMPORTED PLANTS AND PLANT PRODUCTS.

For a number of years the Division of Zoology has been inspecting the importations of plants from abroad into this State. Heretofore the bulk of this work has been done in the vicinity of Philadelphia and is especially voluminous during the fall and spring. At other times of the year the importations fall off to occasional ones only. However, more attention is required than ever before, owing to the rulings of the Plant Quarantine Act, August 20, 1912.

The Plant Quarantine Act became a law by its passage by the United States Congress on August 20, 1912. In its nature it effects the country at large and is "AN ACT to regulate the importation of nursery stock and other plants and plant products; to enable the Secretary of Agriculture to establish and maintain quarantine districts for plant diseases and insect pests; to permit and regulate the movement of fruits, plants and vegetables therefrom, and for other purposes." Section 12 of this act states that "for the purpose of carrying out the provisions of this act there shall be appointed by the Secretary of Agriculture * * * * the Federal Horticultural Board * * * *."

This board thus oversees the inspecting of the importations, receives the reports of the inspectors, and otherwise sees that the Federal Act is complied with in the several States. Not only are importers required to secure a permit from the U. S. Secretary of Agriculture

in order to bring plants or plant products into this country, but they are also required, either personally or through the custom house broker, to notify the State Inspector of the arrival of stock and its movements, so that inspection may be made at the destination and a report of the findings sent to Washington, D. C. This inspection does not cost the importer anything, but is made at the State's expense. The act which requires such inspections to be made has been passed by Congress because it is believed to be necessary legislation. Not a few dangerous insects and plant diseases have come to us from abroad and some Commonwealths have spent a million dollars and more in trying to free themselves from these destructive forms of life. So ever imminent is the danger of importing infested or infected nursery stock that scarcely one package can be allowed to pass uninspected for fear it may be a dangerous one. This office asks the hearty and conscientious support of all the residents of this great Commonwealth that we may be able to fulfill our duty to the National Government as laid down in the Plant Quarantine Act, August 20, 1912.

This act practically divides plants to be inspected into two classes: (1) plants ordinarily called nursery stock, and (2) field-grown florists' stock. This distinction is made in the following tables. As will be noted, the importations of the second class are for the months of October, November, and December; since the Plant Quarantine Act became effective October first, nineteen hundred and twelve.

IMPORTATIONS OF NURSERY STOCK—1912.

Month.	Number of packages.	Number of plants.
January,	571	463,136
February,	353	4,366
March,	2,256	123,353
April,	1,796	139,722
May,	407	203,196
October,	113	4,822
November,	790	260,473
December,	280	648,012
Totals,	6,577	1,352,981

IMPORTATIONS OF FIELD-GROWN FLORISTS' PLANTS—1912.

Month.	Number of packages.	Number of plants.
October,	130	7,694
November,	737	226,718
December,	145	214,624
Totals,	1,012	449,036

PENNSYLVANIA APIARY INSPECTION.

The Legislature of 1911 passed an Act which was duly signed and became effective, authorizing the Secretary of Agriculture through the Economic Zoologist to inspect apiaries, in order to determine the presence of bee diseases and to show how they are to be treated, in order to prevent further loss by these diseases. Such legislation was generally demanded by bee-keepers who have seen the most serious inroads into their apiaries by diseases which they did not understand, but which can be controlled when understood.

It has frequently occurred that bees have died during the winter, or even at some other time of year, in a manner inexplicable by the owner, and the latter has not recognized the fact that their death was due to a disease which could have been cured and the bees saved, had he applied proper methods of treatment. There is no other means of preventing the terrible loss of bees by disease in this State, than sending out persons familiar with the diseases to make inspections and determine their presence and method of handling them. The diseases are curable if treated rightly, and extremely injurious, spreading rapidly among other bees, if not treated rightly.

The U. S. Law prohibits the moving of bees from one State into another without certificates of inspection, and also prohibits the shipping of queen bees without the attachment of a certificate of inspection, or an affidavit that the honey used has been boiled for a certain time. Thus it became necessary for provisions to be made by which apiaries could be inspected and queen breeders could obtain licenses from this Department, although no money was available for the purpose.

To meet the emergency several advanced bee-keepers in this State, who have had experience with bee diseases and knew how to recognize them and treat them, have volunteered their services in the capacity

of voluntary apiary inspectors. They were duly appointed to this position during the year 1912 and inspected such apiaries as they could reach in accordance with the time that each could give to the work. This is a case of true altruism, as the volunteer inspectors gave not only their time and services, but also paid their own expenses, in order to render this help to their fellowmen who were losing their property. These persons deserve unusual credit, as there is no doubt that each one performed important service in checking bee diseases in territory in which he inspected. The names of the volunteer inspectors and reports of the work done by the same respectively are as follows:

Mr. Geo. H. Rea, Reynoldsville, Pa.

Mr. W. A. Selser, 9 Vine Street, Philadelphia, Pa.

Mr. John O. Buseman, 2828 Germantown Ave., Philadelphia, Pa.

Mr. Franklin G. Fox, Pipersville, Pa.

Mr. William Watson, Hanover, York Co., Pa.

Mr. D. C. Gilham, Schuylkill Haven, Pa.

Mr. Penn G. Snyder, Swarthmore, Pa.

Mr. Isaac F. Tillinghast, Factoryville, Pa.

Rev. Calvin Fassold, Williamstown, Pa.







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OF THE

DIVISION OF ZOOLOGY

OF THE

PENNSYLVANIA DEPARTMENT OF AGRICULTURE.

VOL. III.—Nos. 3 and 4.

SUBJECT: { First Report on the Economic
Features of The Amphibians of
Pennsylvania.

MAY-JULY, 1913.

H. A. SURFACE, D. Sci., Economic Zoologist,
Editor

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under the Act of June 6, 1910.*

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Commonwealth of Pennsylvania.

THE BI-MONTHLY ZOOLOGICAL BULLETIN OF THE DIVISION OF ZOOLOGY FOR MAY AND JULY, 1913.

VOL. III, Nos. 3 and 4.

THE AMPHIBIANS OF PENNSYLVANIA.

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PREFACE.

To the Public: We herewith present a Bulletin on some common creatures little known, greatly feared, much abused, and generally shunned; but, withal exceedingly beneficial, as shown by the results of our original and extensive investigations, published for the first time in the following pages.

As far as we have been able to learn this is the first publication ever issued in any language on the Economic Features of the Amphibians. It is offered as a companion publication to our "Serpents of Pennsylvania," September 1, 1906 (edition now exhausted), "Lizards of Pennsylvania," December, 1907, and "Turtles of Pennsylvania," September, 1908. This Bulletin, therefore, completes the study of the cold-blooded air-breathing Vertebrates of Pennsylvania. It shows that none of our amphibians are injurious or harmful in any way. On the other hand they are often very useful destroyers of obnoxious insects, snails and slugs, and some are valuable to mankind because of their edible flesh. They also have their other uses or places in nature's plan, such as bait for fishes, and food of fishes and birds, thus contributing to the sustenance of the organic universe, of which mankind stands at the head.

This publication should be valuable, especially to teachers in schools who wish to make collections, preserve and identify material, and properly use the creatures of their own surroundings as the basis of study for themselves and their pupils. This office will give all desired help in the identification of such material as may be sent to us for this purpose, and also offers to exchange named specimens for others, named or unnamed, if those received are accompanied by data as to dates and places of collection. (See directions for collecting and preserving, on a later page.)

Address all specimens and communications to H. A. Surface, Economic Zoologist, Harrisburg, Pa.

GENERAL REMARKS.

The Amphibian Defined.

The word "amphibian" signifies leading a double life, referring to life on land and in water. Some authors use the word "batrachian" as a synonym, while others limit this application to the tailless amphibians, since the word "batrachian" is derived from a Greek word which means "frog." The name "amphibian" is used for the group of animals here discussed, not through choice, but the application of the Law of Priority, which is accepted among scientists and decrees that the proper scientific name for any organism or group of organisms shall be the one that was first published in proper form with an adequate description or qualification.

The idea of leading a double life is expressed both by the habits of the amphibians and by their corresponding structures. Amphibians possess a back bone or spinal column, and belong to the great Sub-kingdom of Vertebrates. They are cold blooded; that is, the temperature of their body is practically the same as that of their surroundings. In the scheme of classification they are preceded by the lampreys and the fishes and succeeded by the reptiles, and form a connecting link between these classes. Unlike the fishes, the amphibians possess no rayed fins, but when mature generally have functional limbs developed instead. Some species possess gills throughout life, but the majority of the species are provided with those organs only during the larval form,—commonly called the "tadpole" stage. (See Plate I.) Thus amphibians undergo a metamorphosis, or change of form, as their development progresses. The young of most species are aquatic and breathe by means of gills. In fishes these gills are borne on bony arches, while in amphibians they are on fleshy processes. Swimming is facilitated by the fin-like tail, which disappears in many forms, such as frogs and toads, as they approach maturity and leave the water. Generally, too, the gills disappear as lungs develop in their stead. In some species respiration is aided by the skin, which is moist and always naked or without scales. The heart of amphibians, like that of reptiles, consists of two auricles and a ventricle.

Contrast Between Lizards and Salamanders.

Salamanders belong to the class Amphibia, and lizards, to the Reptilia. (See Vol. V, No. 8 of the Zoological Bulletin, Dec. 1, 1907, on "Lizards of Pa.") From the foregoing definitions and this state-

ment it is obvious that salamanders and lizards are very distinct forms, and the words are by no means synonyms, although many persons frequently use them as such. Indeed, true lizards are unknown to many who apply this name to the salamanders, which are much more common. The latter have a smooth skin, while the skin of lizards gives rise to and is covered by scales. The lizards deposit eggs, covered by a shell, while salamander eggs are provided with a transparent gelatinous envelope. Furthermore, lizards never pass through a larval or tadpole stage, never live in water, and never breathe by gills. Amphibians mostly live in wet places, and lizards in dry places.

Habits.

The class Amphibia includes animals known by such common names as "mud puppy," "hellbender," salamander, newt, eft, tree toad, toad, and frog. All possess certain structural features in common, but there are certain ones in which they differ, and they have correspondingly different habits. The mud puppy and hellbender are strictly aquatic at all times. Although adult toads and a few species of salamanders are strictly terrestrial, the great majority of amphibians are aquatic at least during the larval stage. All prefer more or less damp situations. Some forms, as the tree frogs, are arboreal, especially during the summer and fall. With few exceptions, they are most active at night, and are therefore said to be nocturnal.

Hibernation.

Like fishes and reptiles, the amphibians are cold-blooded,—their temperature is variable, but agrees very closely with that of their surroundings. In the case of reptiles, we found by several tests with a thermometer that the temperature of serpents does not differ from that of their surroundings where they have remained long enough to become of the same temperature. There is no doubt that the same is true of fishes and amphibians. It is therefore obvious that these animals are cold-blooded only when in cold surroundings. They should, therefore, be called "isothermic" rather than "cold-blooded." As the cold increases the life processes decrease in activity. This inactivity may occur several times during the year, but is most prolonged during the colder months, when the animals are said to be in "hibernation." In preparation for this the amphibians, like the reptiles, retire to places of shelter. With amphibians these are in the mud on the bottom of streams, springs and ponds, under bark, leaves or logs, in burrows, and in similar situations, where ample protection is afforded. There they become torpid and so remain until the approach of spring. With some species, as the

Green Frog, the period of hibernation ends in February or March; in other cases, activity may not begin until April or May.

Eggs and Reproduction. (See Plate II.)

About the first thing to occupy the amphibians' attention after they come forth from hibernation is mating and depositing the eggs. All amphibians, with the exception of a few species of salamanders that do not occur within our limits, lay eggs. A few species of salamanders deposit their eggs under the bark of trees, under logs, or in similar moist places, but practically all other amphibians seek water in which to oviposit.

The eggs are small, and are generally bi-colored, that is, dark above and pale below. Some are very dark, or even black, while others are of paler shades,—soiled white or gray, or yellow, according to the species. The darkness increases in intensity as incubation progresses, and serves to absorb the heat from the water. The eggs are provided with one or several layers. Those of salamanders and tree frogs are usually in strings, small clusters or singly; frog eggs are generally in large clusters, some containing as many as 6,000 ova; while toads deposit their eggs in characteristic strings, some of which may contain upwards of 12,000 eggs. Clusters of eggs of frogs are distinguished from those of salamanders by the fact that the latter generally are surrounded by a gelatinous envelope which encloses the entire mass, while the former generally are simply the eggs which cling together. Generally the parents desert the eggs after deposition is made, but a few species of salamanders, in which the eggs occur like strings of beads, are said to wrap these strings about the body and remain in concealment. The writer has found some of the Dusky Salamanders in mid-summer curled up with small masses (about twenty) of pearly white eggs, in rock crevices at a spring. The mass in which the eggs occur is of a gelatinous nature, and swells up rapidly after being in the water a few hours, so that it becomes three or four times the original size. Where the water is so deep that the bottom is colder than the top, the egg mass is attached to sticks or other supports to hold it up near the surface in the warm water, or deposited at a shallow edge. This gelatinous mass, generally attached to stems and grasses in the water, but sometimes floating free, serves as food for the young tadpoles. Some, as those of the toad, remain but a few weeks in the water; while others, as those of the Green Frog and Bull Frog, may remain as "polliwogs" for two, or even three, years.

It is especially during the breeding season that the amphibians are heard. Generally speaking, the salamanders are voiceless, but one species is one kind of a "peeper," heard in swamps in the early spring time. The Toad and Wood Frog agree in being unusually

silent except in spring. Then they join with the other species in the chorus which issues from swamp, pond, lake or stream. The vocal cords are in the throat, and the volume of the voice is increased by the inflated pouches, which in the toads and tree frogs is a single throat pouch, but in the frogs (*Ranidae*) is double, and is located on each side, just in front of the shoulders.

Enemies.

The great reproductive powers of amphibians indicate to naturalists that these creatures must have many enemies, and investigation shows this to be true. The eggs or spawn are destroyed in great quantities by leeches, which suck out the contents. The young tadpoles are eaten by water-bugs and beetles, diving-spiders, the larvæ of dragon-flies and caddice-flies, fishes and wading birds. Toads and frogs are eaten in great numbers by fishes, snakes, hawks, cranes, herons, ducks, crows and poultry. The Toad is especially the victim of serpents, such as the common Garter, Ribbon and Water Snakes and the Spreading or Blowing Viper. (See "Serpents of Pennsylvania," by H. A. Surface, Sept. 1, 1906.) Frogs often fall prey to snapping turtles. (See "First Report on the Economic Features of Turtles of Pennsylvania," pp. 124-132, by H. A. Surface, Sept. 1, 1908.) Newts also devour the tadpoles of the smaller amphibians, while Leopard, Green and Bull Frogs are cannibals, and devour the smaller species, and also smaller individuals of their own species. In the "Serpents of Pennsylvania," (1906), we published that we had found serpents eating undetermined amphibians and salamanders, the Red-backed Salamander, the Slimy Salamander, the Two-lined Salamander and the Newt; tadpoles of Salientia, the American Toad, the Common Tree Frog and the Spring Peeper; undetermined Frogs, the Leopard Frog, the Wood Frog, and the Green Frog.

The list of snakes thus proven to feed on amphibians includes such as the following: the Ribbon Snake, the Common Garter Snake, the Queen Snake, the Water Snake, the Pilot Snake, the Grass Snake, the Black Snake, the Ring-necked Snake, the Spreading Adder or Blowing Viper, and the Copperhead Snake.

Food and Economy.

The present bulletin has been prepared with the idea of disseminating knowledge about the amphibians, especially in regard to their food and economy. The examination and analysis of the contents of 1,456 stomachs, of 24 species, in our collection, gives much insight into the food of these animals, which as a group, have received comparatively little study. Indeed, the toad is the only species that heretofore has been investigated with any thoroughness, and th-

facts herewith presented will, therefore, be of interest. Much is yet to be learned of the food of amphibians, and little is known of the food and habits of such species as the Mud Puppy, the Hellbender, and the rarer salamanders. Observations are urged, and records are solicited.

The very young tadpoles almost invariably subsist for the first few days of their life on the gelatinous material that surrounds the eggs or the egg masses, and later turn their attention to aquatic vegetation, such as the algæ, commonly known as "pond scum" or "green slime." The adults live mostly upon insects, many of which are harmful. A more detailed and complete idea of the food can be had by consulting the table at the end of this bulletin. It will be seen that in the food are such beneficial animals, as spiders and ground beetles (Carabidæ). On the other hand, the amphibians devour such destructive creatures as sowbugs, thousand-legged "worms," snails, slugs, mites, grasshoppers, aphids, Lepidoptera (moths, etc.), and their larvæ, flies and their larvæ, and ants. (All flies and ants, however, cannot be rated as injurious.) The results of investigations show that the amphibians, as a rule, feed upon a class of food similar to that of the toad, a creature whose food has been investigated quite thoroughly. For this reason we did not consider it advisable to make further investigations with particular reference to the toad. Its value as a consumer of destructive insects and closely related creatures has been established beyond question. (See "The Common Toad," by Dr. C. F. Hodge; "Usefulness of the American Toad," by A. S. Kirkland, Farmers' Bulletin 196, U. S. Dep. Agr., and others cited in the bibliography at end of this bulletin.) In a similar way, the terrestrial amphibians are to be regarded as friends of agriculture, and they deserve protection accordingly.

For securing this food, the tongue of amphibians is peculiarly well fitted. In the salamanders the tongue is attached to the floor of the mouth by a growth or structure known as the pedicel, and in some species there is further attachment at the sides. In the frogs and toads, however, the tongue is attached in front only and can be thrust forward from the mouth and protruded a remarkable distance with lightning-like quickness. Moreover, the tongue is provided with a sticky secretion which serves to hold the prey firmly. Some species, as the Tree Frogs and Cricket Frogs, progress by leaps toward the prey; the Common Toad moves stealthily upon its victim; while most frogs and salamanders generally await its approach. Salamanders also feed extensively on insects on and in the water.

In addition to the fact that the amphibians as a whole are constructive, rather than destructive, to man's interests, some species as those of the frogs, serve as food for man. Dr. C. F. Langworthy

("Fish as Food," U. S. Dept. of Agriculture, Farmers' Bulletin No. 85), has shown that the legs of frogs contain 32.0 per cent. refuse (bone, skin, etc.), 56.9 per cent. water, 10.5 per cent. protein, 0.1 per cent. fat, and 0.7 per cent. ash or mineral matter, or 11.3 per cent. total nutrients. The latter figure is quite low when compared with many other foods, so that frogs are to be regarded more as a delicacy than as rich food material. However, their flesh contains a favorable amount of protein, which is the nourishing constituent of meats in general, but usually lacking in many vegetables. In many parts of this country procuring and selling frogs has become a paying industry, so much so that several species have been greatly reduced in numbers. In Pennsylvania, as a result, legislation has been enacted which makes it illegal "to catch, take, or kill any bull-frogs, only from the first day of July to the first day of November." A further economic feature of the amphibians is found in the fact that their young or tadpoles are taken extensively as food for fishes, thus contributing indirectly to the nourishment of mankind, and they are also used as bait by fishermen. In fact, their use as bait has threatened the reduction or extermination of tadpoles and frogs to such an extent that a bill was introduced into the last Legislature providing that not more than 20 tadpoles could be used as bait in one day. However, the bill failed to become a law.

COLLECTING AND PRESERVING SPECIMENS.

The ideal time for collecting amphibians is in the spring, after the frost has left the ground. Then frogs, toads, and salamanders are more easily secured and in greater numbers. Of course, at this time most of the creatures will be found in or near the water, whence they have gone to deposit their eggs. Then, as at other times, they prefer the dark and are most active early in the morning or late in the evening. A bull's eye lantern serves a most useful purpose as its light enables the collector to see, but bewilders the game. Very early in the spring and after the breeding season salamanders may be found in old stumps, under stones, in wet moss, among decaying leaves and in similar situations.

A quick, well-aimed grasp of the hand will often secure many specimens, but a dip-net will be found to be of great value. More frogs can be secured with a gun than by any other means. Use cartridges loaded with mustard seed shot in a rifle of .22 or .32 caliber.

Alcohol and formalin (or formaldehyde) are good preserving fluids. Alcohol is generally 95% strength, and formalin, 40%. If the col-

lector be going only a short distance from home he can dilute the liquid before starting. Otherwise, the concentrated liquids should be carried to the field and diluted there. In some cases, however, the specimens can be carried home or to the laboratory, and there placed in the preservative. If alcohol be used it should be diluted to 40% for the first immersion (dilute in the proportion of 40 cc. of 95% alcohol to 55 cc. of water or 40 volumes of the former to 55 volumes of the latter). By means of a hypodermic syringe inject diluted alcohol into the body cavity or with fine pointed scissors make an incision in the under surface of the body. This is very important since, if the injection or incision be not made, the preserving fluid will not penetrate the body wall, and decay will set in. Allow the specimens to remain in the 40% alcohol for a week, and then transfer to 50% alcohol (dilute in the proportion of 50 parts of 95% alcohol to 45 parts of water). If formalin be used instead of alcohol dilute the commercial fluid to 2% (by adding 19 parts of water to one part of 40% per cent formalin) for the first immersion, and to 4% (by adding 9 parts of water to one part of 40% formalin) for the final preservative.

A note book record should be kept of all specimens secured. Such a record should include locality, date, character of place where taken (whether in woods, water, under log, kind of soil, etc.), and colors of the specimens when fresh. (The colors will largely disappear through the influence of the preservative). Assign a number to each specimen, and record the specimen in the note book by number and name. About six average-sized specimens of one species make a good series: also specimens of eggs and young in various stages of growth should be preserved for each species.

Every specimen should be provided with a label, the data for which are secured from the note book entry. Parchment paper is best for labels. These should be about $\frac{3}{4}$ inch x 3 inches. The writing should be done with a lead pencil of medium hardness, or with India ink. In the case of frogs and toads, the string of the label is tied around the body in front of the hind legs; while in the case of salamanders, the string is placed around the body behind the forelegs. (Further detailed information on collecting and preserving amphibians can be secured from Part E of Bulletin of the United States National Museum, No. 39).

To the general public this information is of little avail unless the average person is able to recognize these friends. As a means toward this end we have prepared keys to and descriptions of the species occurring within our Commonwealth, in the hope that more persons may get an insight into the "Kingdom of Animals" and appreciate how, as the results of their living, they maintain the "balance of nature."

THE CLASSIFICATION OF PENNSYLVANIA AMPHIBIA.

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KEY TO THE ORDERS OF PENNSYLVANIA AMPHIBIA.

-
- A. Body lengthened, with a distinct tail throughout life; hind limbs not especially enlarged.
- a. External gills and gill-clefts persistent throughout life, the gills three on each side; no eyelids,I. PROTEIDA, page 78
- b. External gills disappearing in adult life,.....II. URODELA, page 81
- B. Body short and depressed; tail disappearing with age; the posterior limbs much enlarged for leaping,III. SALIENTIA, page 109

COLOR KEY TO THE SALAMANDERS OF PENNSYLVANIA.

This "Color Key" is based chiefly on the following colors:

(I) Black, (II) Brown, (III) Olive Green, (IV) Lead Color, (V) Red and (VI) Yellow. ("Length" is given for full grown specimens).

- I. Black.**
- a. Black above, with bluish gray bars; belly dark blue; body stout. Length $3\frac{1}{2}$ inches or less,No. 3. *A. opacum*, page 86
 - b. Black above, with a series of round, yellow spots on each side of the back; body broad; strong dorsal groove. Large species. Length 6 inches,No. 4. *A. punctatum*, page 87
 - c. Usually with bluish white blotches and specks; stout; tail rounded. Length 5 to 7 inches,No. 10. *P. glutinosus*, page 96
 - d. Uniform black, stout body; costal grooves 12; tail compressed and keeled. Length 6 inches,No. 17. *D. nigra*, page 106
- II. Brown.**
- a. With yellow in the coloration.
 - a'. Dark brown, usually with many irregular, yellow blotches, sometimes in cross-bands; body thick. Large species. Length 8 inches,No. 6. *A. tigrinum*, page 80
 - b'. Purplish or yellowish brown above, irregularly blotched with gray; head broad; tail rounded at base; costal grooves 14. Length 6 inches,No. 11. *G. porphyriticus*, page 97
 - c'. Brown above; snout yellow; whitish below, with dots like ink-spots; body short; costal grooves 13. Length $2\frac{1}{2}$ inches,No. 8. *H. scutatum*, page 92
 - b. Without yellow in the coloration.
 - a'. Body marbled below; above with gray or purplish shades which become black with age; eyes prominent. Length 4 inches,No. 15. *D. fusca*, page 104
 - b'. Body not marbled below. Olive brown or blackish, usually with pale or bluish spots; head small; body slender. Length 5 to 8 inches,No. 7. *A. jeffersonianum*, page 90
- III. Olive green.**
- a. Olive green to red, of varying shades above; lemon yellow below; each side usually with a row of several rather large scarlet specks, each surrounded by a black ring; pale streak on back; small black spots on the under surface. Length $3\frac{1}{2}$ inches,No. 16. *D. viridescens*, page 107
- IV. Lead color.**
- a. With one or two series of small yellowish spots along the sides; body slender; small species,No. 5. *A. conspersum*, page 89
 - b. Often with a broad reddish-brown dorsal band; belly marbled; body very slender; tail cylindric. Length $3\frac{1}{2}$ inches,No. 9. *P. cinereus*, page 93
- V. Red.**
- a. Vermilion red, skin smooth and moist, with numerous, crowded, faint, dark spots; head wide; tail shorter than the body. Length 6 inches,No. 14. *S. ruber*, page 101
 - b. Bright vermilion red and with the skin rather rough; otherwise very similar to and a variety of No. 16. *D. viridescens*, which see,No. 16. *D. viridescens miniatus*, page 108
- VI. Yellow.**
- a. A dark line along each side of the back; belly unspotted; costal grooves 14, rather faint.No. 12. *S. bilineatus*, page 98
 - b. Orange-yellow; back and sides with many irregular, small, black spots; a median dorsal series of these; belly unspotted; tail with black spots or bars. Length 5 inches,No. 13. *S. longicauda*, page 100
 - c. Brownish yellow, with a brown shade on each side; a yellow dorsal band; a few spots on the back, but the underparts are unspotted. Length 3 inches,No. 15. *D. ochrophæa*, page 104

REMARKS ON THE KEYS TO THE ORDERS, FAMILIES, GENERA, AND SPECIES OF PENNSYLVANIA AMPHIBI- ANS.

Because of certain relationships of the species of living things—plants and animals—these are classified in groups, which are divided again and again according to their affinities, as shown by their structures. Thus all animals belong to the Animal Kingdom, and this is divided into Phylæ or Branches, these into Classes, then Orders, Families, Genera, and Species. This gives the great system of classification which is so essential in study and identification. In the present bulletin, as in previous ones of like nature, we have followed the scheme of classification given by Prof. David Starr Jordan in the 9th edition of his “Manual of the Vertebrate Animals of the Northern United States.”

The Amphibians form a Class, and their classification and identification, therefore, begin with the Orders. Suppose we have a specimen which we find belongs to the order Salientia. We then refer to the key to the Families of that Order. When we have ascertained the Family to which the specimen belongs we turn to the Key to the Species of that Family.

In the case of the mud puppy there is but one species, genus, family, and order represented within our limits. In like manner, there is but one species in each of the Families Cryptobranchidæ, Bufonidæ, and Pelobatidæ. In such cases, therefore no further keys are required.

Since this bulletin will get into the hands of many persons who have difficulty in using purely technical keys, we have tried to reduce the language to the simplest form. As a further aid, illustrations are supplied, and a glossary of terms is added. The Color Key to the Salamanders is given with the hope that many may be aided in determining the species, but the Structural Key is more reliable and satisfactory for students. It must be borne in mind, however, that color keys are quite superficial in their nature, and those beginners who wish to advance in nature study should use the Color Key merely as a “primer,” and as advancement is made refer to the technical keys which are more reliable.

ORDER I. PROTEIDA. THE GILL-RETAINERS.

FAMILY I. PROTEIDÆ. THE MUD PUPPIES.

The family Proteidæ is a small one, having representatives in Europe and America. The species have bushy, external gills through

out life. The teeth are well developed, and there are four limbs. The species, which are regarded as low forms of salamanders, have but one representative within our limits.

No. 1. *Necturus maculosus* Raf. The Mud Puppy or Water Dog.

The Mud Puppy is dusky to brown and more or less spotted. The gills, which consist of three bushy tufts, are large and bright red in color. The head is broad and flattened, and the tail is much compressed. There is a strong fold across the throat. The animal may attain a length of twenty inches. It possesses two pair of legs, the feet of which are provided with four toes each.

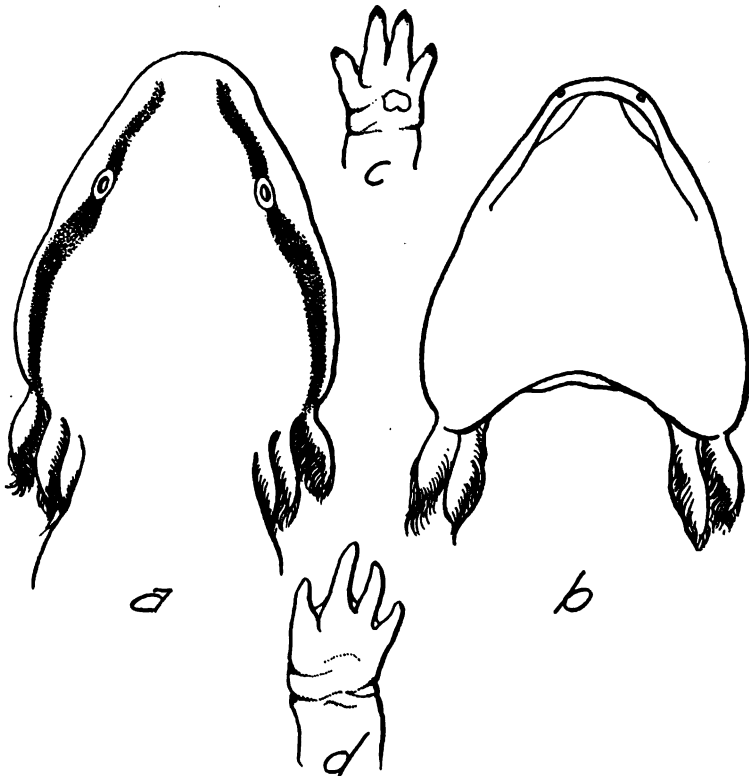


Fig. 1.—Structural characters of the Mud Puppy (*Necturus maculosus*): a, dorsal view of head; b, ventral view of head; c, fore foot; d, hind foot. About 1 2-5 times natural size.

Original drawings from the Office of the State Zoologist.

It is confined to the Eastern United States, where it occurs chiefly in the Great Lakes Region (Jordan); the tributaries of the Mississippi, and the waters flowing into the Gulf of Mexico and into the Atlantic Ocean as far north as the Tar River, North Carolina

(Cope). Eycleshymer states that they are most frequently observed in quiet waters from four to eight feet deep, where a clean, sandy bottom is fairly well covered with vegetation.

As but very little has ever been published concerning the habits of the Mud Puppy, Water Dog or *Necturus*, we take pleasure in giving the results of our personal observations of this interesting and harmless animal in this State and New York..

In the lakes of the latter State the *Necturus* is so very abundant as to become objectional from the economic standpoint, because it feeds upon fishes or the materials taken as food by the best species of fishes. Among its food elements the crayfish forms a most conspicuous part, and this also is the chief food of such fishes as the black bass of both species, wall-eyed pike, perch and the other spiny-rayed fishes which include most of those commonly known as the game fishes.

The *Necturus* lives under flat stones and is caught in considerable numbers by turning these over with an implement like an iron garden rake, and scooping it up with a dip net of large mesh like a minnow net. Where they are in a running stream all that is necessary is to turn the stone suddenly down stream, and quickly put the net in place just over it and catch the salamander as it is washed down by the sudden force of water before it has time to get under way in swimming. They are also caught in great numbers on set lines baited for cat fish and eels. Frequently I have known the greater portion of the catch to consist of these large salamanders, and as fishermen are often afraid of them it is not unusual that they cut the lines holding them and turn them loose. We have seen it not unusual to catch from twenty to thirty water dogs on the hooks of one stretched line in one night.

The *Necturus* is a good swimmer and will swim by holding its short legs against its side propelling itself by means of its strong, flat tail, which is provided with a continuous membrane like a fin extending around from above to below. In the early spring they swim up stream in great numbers, then causing much annoyance to the persons who fish with lines at night by taking the bait or swallowing the hook. They proceed up stream for some distance, and it is the belief of the writer that they deposit their eggs under flat stones in the water, as described on another page of this Bulletin for the Hellbender. In the month of April we found one egg being carried down the stream by high water. It was light yellow, not quite as large as a pea, and with gelatinous cover.

Our collection includes specimens from the following:

Dauphin County, Surface, H. A., Harrisburg, Pa.

Indiana County, Wehrle, R. W., Indiana, Pa.

St. Tammany County, Geist, Karl, Covington, La.

"They are nocturnal in habits, hiding under boards, stones or vegetation during the day. They crawl about on the bottom and use the powerful tail in swimming, but do not swim far,—at most a few yards."—(Dr. Samuel Kneeland).

"Concerning their natural food," says Eycleshymer, "little is known beyond the fact that dissections of the alimentary tract reveal the presence of small crustaceans, insect larvæ and occasionally a small fish." In the laboratory of the Economic Zoologist, twenty specimens were examined, and of eighteen of these the stomachs contained food. The inorganic matter, contained in their stomachs and undoubtedly taken in with the food, consisted of stones, sand, clay, etc. Four were infested by tapeworms. Four contained earthworms; 1, a snail; 4, Crustacea, undermined; 4, crayfish, undetermined; 1, sowbug; 1, spider; 1, insect larva, undetermined; 2, nymphs, undetermined; 5, Odonata or Dragon Fly nymphs; 1, caddice fly larva; 1, beetle, undetermined.

ORDER II. URODELA. THE SALAMANDERS.

The Order Urodela is distinguished from the Order Proteida by the absence of persistent external gills. Five families are recognized as occurring in our State. These are discussed in detail in the following pages.

STRUCTURAL KEY TO THE FAMILIES OF URODELA.

A. Side of neck with a spiracle or rounded opening; no eyelids.

II. *Cryptobranchidæ*, page 82.

B. Side of neck without spiracle or opening in adult; eyelids present.

a. Palatine teeth in a transverse series inserted on the posterior portion of the vomer. (See Figs. 4, 6, 8, 9, 10, 11, 12, 13.)

a'. Vertebræ amphicœlian (double concave).

a". Parasphenoid (behind vomer) without teeth (See Fig. 4); carpus and tarsus ossified; tongue large and thick and with radiating folds, its margin little free.

III. *Amblystomatidæ*, page 85.

b". Parasphenoid with teeth (See Figs. 6, 8, 9, 10, 11, 12); tongue small and largely free.

IV. *Plethodontidæ*, page 91.

b'. Vertebræ opisthocœlian (concave behind only); teeth on parasphenoid; palatine teeth often wanting; tongue moderate, largely free; toes five.

V. *Desmognathidæ*, page 103.

- b. Palatine teeth in two longitudinal series diverging behind (See Fig. 14), inserted on inner margin of two palatine processes; parasphenoid toothless; vertebræ opisthocælian; tongue small and largely free.

VI. *Pleurodelidæ*, page 107.

FAMILY II. CRYPTOBRANCHIDÆ. The Giant Salamanders.

Two species of giant salamanders are known. One occurs in Japan and the other in North America. They attain a length of two feet or more, have a robust body, and four well-developed limbs. The gills are internal, but there is a spiracle or opening on each side of the neck, through which water flows for respiration purposes. Both species are strictly aquatic.

No. 2. *Cryptobranchus alleganiensis* (Daudin). The Hellbender.

The hellbender can be distinguished from the Mud Puppy or Water Dog by the fact that the gills of the former are internal. (The generic

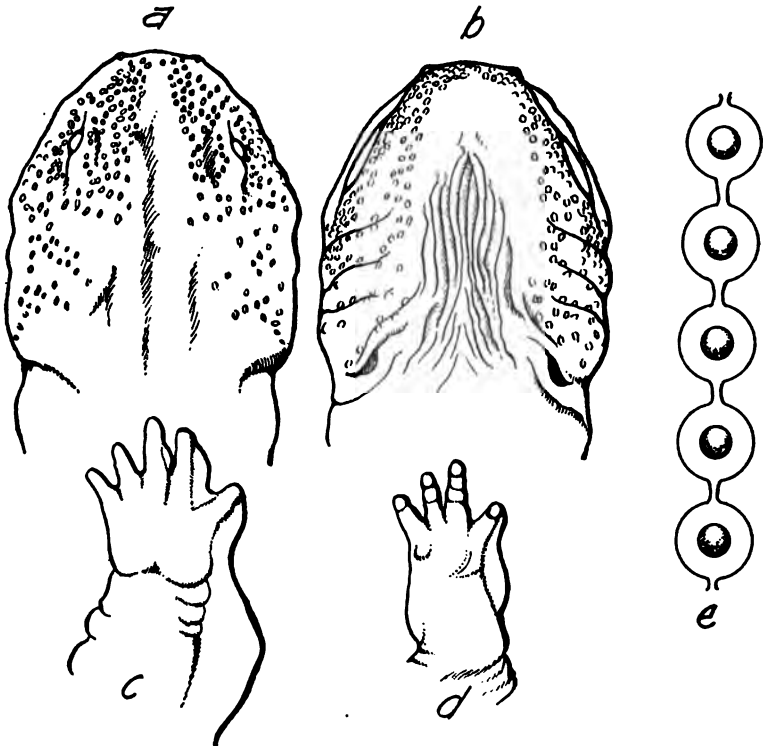


Fig. 2.—Structural characters of the Hellbender (*Cryptobranchus alleganiensis*): a, dorsal view of head; b, ventral view of head; c, hind foot; d, fore foot; e, eggs. About natural size.

Original drawings from the Office of the State Zoologist.

name "Cryptobranchus" signifies "hidden gill"). It is blackish in color and has a thick fold of skin along the side of the body, and reaches a length of two feet. There are two pairs of well developed limbs. The fore feet possess four toes, while the hind feet have five in distinction from the Mud Puppy, which has but four behind. This is our largest Salamander.

Dr. Jordan gives its distribution as "Ohio Valley and southward," while Prof. Cope states it is "distributed from Western New York and Pennsylvania and the Great Lakes to Iowa and south to Georgia, North Carolina, and Louisiana." Our specimens are as follows:

Beaver county,	Mansfield, I. F.,	Beaver.
Cumberland county,	Lee, Alex. H.,	West Fairview.
Cumberland county,	Shatto, W. H.,	West Fairview.
Cumberland county,	Smith, Harry,	West Fairview.
Cumberland county,	Surface, H. A.,	Bowmansdale.
Dauphin county,	Carr, Grace,	Harrisburg.
Dauphin county,	Hawkins, J. H.,	Harrisburg.
Dauphin county,	Parthenore, E.,	Harrisburg.
Erie county,	Lewis, Ed. M.,	Union City.
Indiana county,	Wehrle, R. W.,	Indiana.
Lancaster county,	Mayer, Dr. H.,	Willow Street.
Lancaster county,	Kautz, E. M.,	Lancaster.
Somerset county,	Carbis, S. H.,	Rockwood.
Venango county,	Zool. Office Attaches,	Eagle Rock.
York county,	Hoover, T. B.,	Wellsville.

The counties of Beaver, Erie, Indiana, and Somerset fall within the limits given above. Mr. Henry W. Fowler suggests that certain New Jersey specimens were probably introduced (into that State). "It may have escaped from aquaria, as about 1860 quite an interest was taken in aquatic life in Philadelphia. Many animals were brought from distant localities and in some instances were freed in the Delaware Valley." The actual means by which the Hellbender got into the waters of Pennsylvania east of the Allegheny Mountains is unknown and any explanation which might be offered would be simply conjecture, but it probably merely followed down the streams from the central part of the State, having crossed the divide at an elevated swamp.

A valued correspondent and careful observer, Mr. R. Wehrle, of Indiana, Pa., wrote as follows concerning the habits of the *Cryptobranchus*: "In regard to the hellbender, or better known as the 'alligator,' which is a constant annoyance to the fisherman, and would better be called 'scavenger,' as they eat anything and everything. I have cut them open, not only once but a number of times, and have found two or three good sized specimens of their own kind in one of them, which it had captured and devoured. I have captured them early in the spring when the ice was on, also very late in the fall. They are always ready for a meal, and their habits are not unlike those of the yellow catfish. I think they would be just as good to eat if prepared and served to us in the same manner and called 'catfish.'

"The 'mountain alligator' has but two enemies, and they are the turtle and the snake. Several years ago while fishing in the Black Lick Creek I shot a good sized sucker, near the middle of the stream, and the blood ran down stream. I let the fish remain until I could climb down a tree, which was not over five minutes. In that short time I counted ten of these so-called alligators or hellbenders coming up the stream with their heads moving back and forth, scenting the blood from the fish, and I had to put three balls into the first one to stop him. Then I did not kill him, and lost my fish after all.

"In regard to their spawning habits I know nothing. I have found very small specimens of them. A number of years ago while fishing in the Conemaugh River I shot a good sized water snake, and on cutting it open found a small hellbender in it."

But little has been published concerning the habits of the Giant Salamander or Hellbender. It is fearfully but needlessly dreaded by fishermen, who often take it on their hooks while fishing for suckers or catfish during winter or spring. In appearance it really is a hideous creature, and as it reaches a length of over two feet, and is by all means our largest salamander, it is no wonder that it is feared by the laymen.

Concerning its breeding habits and the life of its young almost nothing is known or published heretofore. The eggs are laid in the fall of the year under large flat stones, where the water moves freely, and not along the "muddy banks of rivers," as has been suggested. On September 17th, 1909, we found a large mass of freshly laid eggs of this species under a large stone in the Susquehanna River, just above Harrisburg, where the water was two feet deep and running rapidly. The entire mass in quantity was sufficient to fill a man's hat. The individual eggs were sulfur yellow and as large as peas, each surrounded by a clear gelatinous envelope, which made a sphere over one-half inch in diameter. These spheres were connected in strings by a gelatinous neck of the same substance surrounding the eggs, showing that they had been laid in strings, although the entire mass was bunched under the stone. It is probable that they remain unhatched during the winter, and hatch and feed in the spring, as do the eggs of certain land salamanders.

In September, 1907, Messrs. McConnell and Noll, collecting specimens for this office and the Fish Commission found similar masses consisting of the strings of eggs of these salamanders under stones in shallow water in the Allegheny River in Venango County, and the adult females near them, showing that they had but recently spawned.

The Hellbender is wholly aquatic, but very little has been published concerning its habits. "It is frequently taken by fishermen on hooks" (Cope). We have seen Hellbenders in captivity snap when annoyed, but they are perfectly harmless.



Plate I., Fig. 1.—Salamander tadpoles, showing the external gills (about twice natural size). Photographed in the office of H. A. Surface, Economic Zoologist.

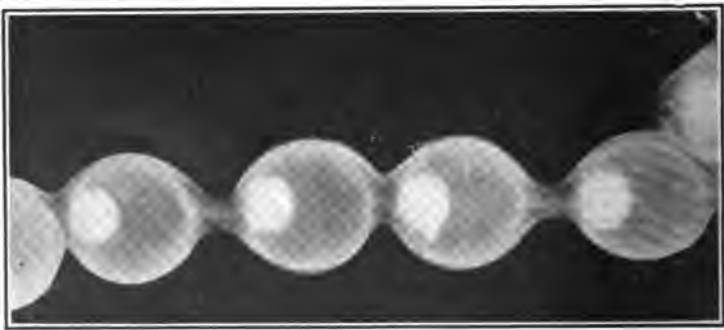


Plate I, Fig. 2.—Eggs of the Hellbender (*Cryptobranchus alleganien-sis*), showing manner of attachment of the eggs, one to another. About natural size. Photographed in the office of H. A. Surface, Economic Zoologist.

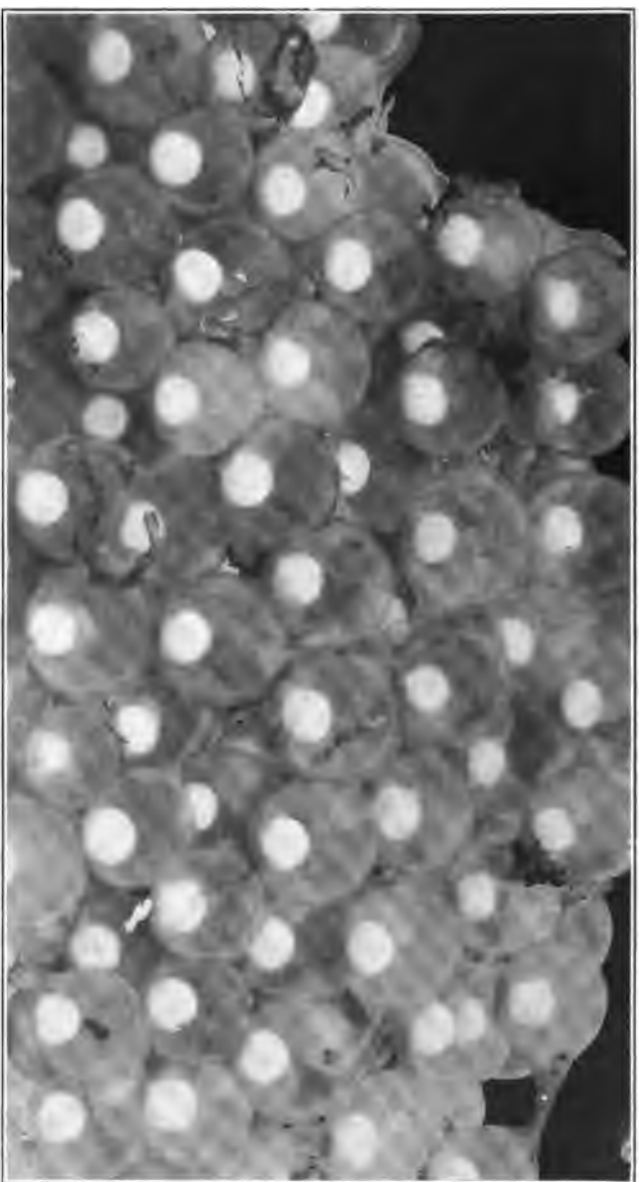


Plate II.—Eggs, en masse, of the Hellbender (*Cryptobranchus alleganiensis*). About natural size. Photographed in the office of H. A. Surface, Economic Zoologist.

Prof. Cope concludes, "its larval period must be of brief duration since it has not yet been observed. The eggs are rather large and are attached by two strong suspensions at opposite poles." "Oviposits in August and September, probably for this purpose visiting the muddy banks of rivers. The eggs are at first about the size of a pea, enveloped in a glairy albuminous fluid. They are connected in strings and increase after oviposition by inhibition of water."—(Smith, Geol. Surv. of Ohio).

"Hellbenders are said to be very voracious and feed upon worms, crayfish, fishes and aquatic reptiles."—(Smith). This office received seventy-two specimens, sixty-four of which had food in the stomach. This consisted of earthworms, mussels, crayfish, insects, undetermined vertebrates, fishes, and plant material. By reference to the table it will be seen that crayfish form the principal article of diet. Crayfish are known to cause considerable damage in some sections where the land is damp, though suitable for certain crops. In our own State they are to be rated as neutral in direct influence, although quite important as food of fishes. In consideration of this the Hellbender may be said not to affect man's economic interests to any great extent, although it is of great scientific interest and worthy of the attention of students.

FAMILY III. AMBLYSTOMATIDÆ. THE BLUNT-NOSED SALAMANDERS.

This and the following Family of Salamanders (Plethodontidæ) differ from the Giant Salamanders in that they possess no spiracle on the side of the neck, and also in other structures. In the present family there are no teeth on the parasphenoid bone; the tongue is thick, large, has radiating folds, and most of the margin is attached to the floor of the mouth. Five species occur within our limits. All of our species of this family belong to the one genus, *Amblystoma*.

STRUCTURAL KEY TO THE SPECIES OF AMBLYSTOMATIDÆ (GENUS AMBLYSTOMA).

A. Costal Grooves, 11.

- a. Body with gray cross shades, black above, with about 14 bluish gray cross bars; belly dark blue; body stout; 3½ inches long.

No. 3. *Amblystoma opacum*, page 86.

- b. Body with yellow spots.

- a'. Black above, with a series of round yellow spots on each side of back; body broad; a strong dorsal groove. Length 6 inches.

No. 4. *Amblystoma punctatum*, page 87.

- b'. Lead above, with one or two series of small yellowish spots along sides; no dorsal groove; skin smooth; body slender; small.

No. 5. *Amblystoma conspersum*, page 89.

B. Costal grooves, 12.

- a. Sole with two distinct tubercles; snout with numerous pores; dark brown, with usually many irregular yellow blotches, sometimes in cross bands; body thick and strong, length 8 inches.

No. 6. *Amblystoma tigrinum*, page 89.

- b. Sole with one indistinct tubercle or none; olive brown or blackish, usually with pale or bluish spots, but sometimes uniform plumbeous. Head small, eyes far back; body slender. Length 5 to 8 inches.

No. 7. *Amblystoma jeffersonianum*, page 90.

DISCUSSION OF AMBLYSTOMATIDÆ BY SPECIES.

No. 3. *Amblystoma opacum* (Gravenhorst). **The Blotched Salamander.**

Several common names are applied to this species, such as Blotched, Marbled, and Opaque Salamander. It is black above, while the under parts are dark blue. The back is marked by fourteen bluish gray bars. There are eleven costal grooves. Specimens average three and one-half inches in length.

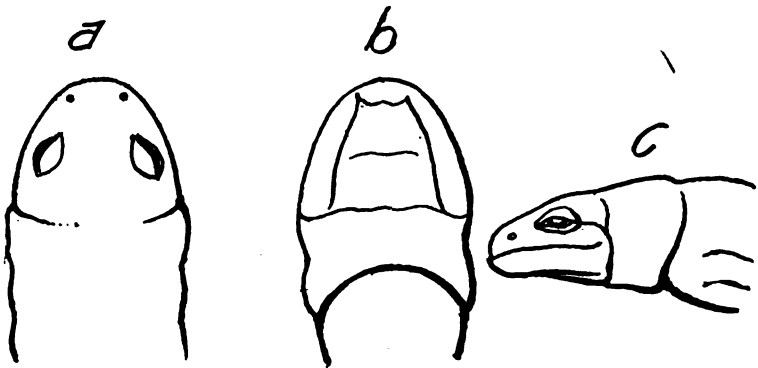


Fig. 3.--Structural characters of the Blotched Salamander (*Amblystoma opacum*): a, dorsal view of head; b, ventral view; c, lateral view. Twice natural size.

Original Drawings, from the Office of the State Zoologist.

This species is said to occur "from Pennsylvania to Wisconsin and Southward." Our specimens are from three counties in the eastern half of the State, as follows:

Chester county,	Berry, Israel R.,	Coatesville.
Franklin county,	Lehman, A. B.,	Fayetteville.
Perry county,	Brightbill, Harry,	Marshrun.
Perry county,	Brightbill, Mrs. H. A.,	Marshrun.

Salamanders, as a rule, prefer wet or moist situations. In the Blotched Salamander we find an exception, as this species selects dry places, where it is found under stones and in burrows in sandy soil.

The eggs are deposited in the water and hatch late in April or early in May. The larvæ develop very rapidly and leave the water about the first of July. About this time their dull gray color, thickly marked with white dots, is replaced by the adult coloration. Mann states that this animal lays its eggs in the beds of small ponds, and in some cases the number of these amount to one hundred and eight. He found them in these situations in summer and also in November, and always with the male and female curled up over the eggs as if in the process of incubation. (Smith, Geol. Surv. of Ohio). The writer has found them in small crevices or cavities near springs in August.

We do not find any reference in literature to the food of the Blotched Salamander. Three of the seven specimens we examined had food in the stomach. One contained earthworms; a second, Staphylinid or "Rove" beetles; and the third undetermined insect larvæ. This proves their insectivorous habits, and indicates their possible value in this regard in regions where they are abundant.

No. 4. *Amblystoma punctatum* (Linn). **The Spotted Salamander.**

Perhaps few salamanders are better known to the average person than the Spotted Salamander. Its general body color is black, marked above with several round, yellow spots on each side of the broad, depressed body. The skin contains small pores through which exudes a milky, acrid fluid. In the head are found two or three clusters of enlarged pores. A distinct groove extends along the back. There are usually 11 costal grooves and sometimes 10. Adults average 6 inches in length.

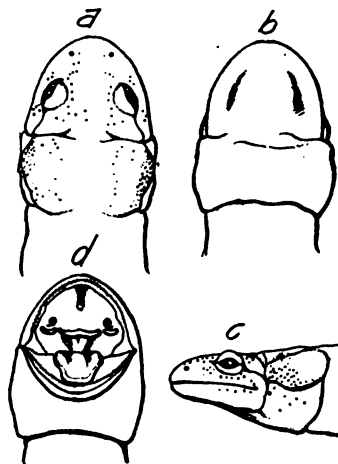


Fig. 4.—Structural characters of the Spotted Salamander (*Amblystoma punctatum*): a, dorsal view of head; b, ventral view; c, lateral view; d, ventral view, mouth open. About natural size.

Original Drawings, from the Office of the State Zoologist.

The Spotted Salamander is a common species over the eastern and central portions of North America. Our collection includes examples from twenty-six counties, representing practically all sections of this State. Doubtless this species occurs in all the counties.

Allegheny county,	Atkinson, Dr. D. A.,	West View.
Allegheny county,	Cruikshank, Dr. O. F.,	Swissvale.
Armstrong county,	Henry, Dr. F. J.,	Apollo.
Berks county,	Bortz, Dr. D. W.,	Esterly.
Berks county,	Ludwig, A.,	Temple.
Blair county,	Young, J. S.,	Holidaysburg.
Bradford county,	Crammer, Mrs. S. M.,	Granville Summit.
Bradford county,	Pay, G. P.,	Athens.
Bradford county,	Flemming, B.,	Granville Summit.
Bradford county,	Ringer, Mrs. A.,	Wyalusing.
Bradford county,	Warburton, G. N.,	Granville Summit.
Bucks county,	Godshalk, S. Y.,	Perkasie.
Bucks county,	Van Sant, Belle,	George School.
Cambria county,	Settlemyer, C. F.,	Wilmore.
Cameron county,	Blinzler, John,	Emporium.
Cameron county,	Hellman, Dr. R. P.,	Emporium.
Centre county,	Baker, J. D.,	Phillipsburg.
Centre county,	Hazel, A. J.,	Madisonburg.
Chester county,	Clemenson, Wm. W.,	Honeybrook.
Clarion county,	Blyson Camping Party,	Blyson.
Clearfield county,	DeHaas, L. F.,	Shawville.
Columbia county,	Andrews, C. H.,	Reaver Valley.
Dauphin county,	Maher, John J.,	Williamstown.
Erie county,	Waxer, E. M.,	Waterford.
Luzerne county,	Campbell, E. W.,	Wilkes-Barre.
Luzerne county,	Pink, H. L.,	Shickburg.
Luzerne county,	Johnson, F. C.,	Wilkes-Barre.
Luzerne county,	Wayne, Jas.,	Wilkes-Barre.
McKean county,	Dickey, J. E.,	Olivevale.
McKean county,	Young, J. C.,	Degolia.
Monroe county,	Gould, C. H.,	Effort.
Northampton county,	Davidson, Prof. Alvin,	Easton.
Northampton county,	Walk, E. W.,	Pen Argyl.
Northumberland county,	Grades, John,	Shamokin.
Perry county,	Brightbill, H. A.,	Marshrun.
Potter county,	Rugsaber, Chas. F.,	Galeton.
Sullivan county,	Wright, E. B.,	Parkesville.
Susquehanna county,	Brown, N. S.,	Springville.
Susquehanna county,	Mosher, J. M.,	New Millford.
Tioga county,	Andrews, F. S.,	Wellsville.
Tioga county,	March, J. G.,	Lawrenceville.
Wayne county,	Bullock, Wm.,	Honesdale.
Wayne county,	Merrigan, John,	Starucca.
Wayne county,	Quentin, E.,	Ariel.

This species occurs under logs, stones and decaying matter in damp woods, and "sometimes in cellars and appears to be nocturnal" (Smith). Late in March or early in April the adults repair to ponds and small streams, where the eggs are laid in a gelatinous mass much like that of frogs. This is one of the species that is popularly thought to be very venomous, but it is perfectly harmless, as are all other salamanders.

As with the preceding species, literature reveals practically nothing on the food habits of the Spotted Salamander. Fifty-four specimens were examined in the laboratory of this office and of these, thirty-one contained food. In this food earthworms, snails, slugs, spiders, thousand legged "worms", crickets, ground beetles, rove beetles, ants and other insects play an important part, and prove clearly the beneficial effects of this animal in regard to its indirect value to mankind.

No. 5. *Amblystoma conspersum* (Cope). **The Speckled Salamander.**

The Speckled Salamander is of a lead color with yellow spots distributed along the sides in one or two series. Unlike the preceding there is no dorsal groove and the skin is smooth and the body slender. This is a small species.

It is found from Pennsylvania to Georgia (Jordan) but appears to be so rare or of such casual occurrence that little is known or written of it. We have no specimens in our collection. Collectors are especially invited to watch for it and send us specimens.

No. 6. *Amblystoma tigrinum* (Green). **The Tiger Salamander.**

This conspicuously marked salamander is also known as the Tiger Triton. The prevailing color is dark brown, with usually many irregular, yellow blotches, which sometimes are arranged in cross bands. The body is thick and strong. Some individuals are much lighter in color than others, but the spotted character is quite constant. Adults attain a length of eight inches.

The Tiger Salamander is found from New England to Minnesota and Southward, common (Jordan); the entire United States and Southern Canada, Northern and Central Mexico (Ditmars). We have not secured any examples of this species from Pennsylvania.

This species is nocturnal and hides during the day in burrows, under logs and other places of concealment. The larvæ are said to become terrestrial in late summer when about six months of age, but they are known to be quite irregular in this respect. Indeed, this irregularity has caused some confusion, so that the aquatic forms have been given various names. Adverse weather conditions retard the development so that some individuals linger in the water

and in this larval form are said to breed and deposit eggs. The retiring habits of this species account, no doubt, for the fact that we have received no specimens from residents of this State. We shall be glad to receive specimens at any time and incorporate the results of their study in our Second Report on Salamanders when prepared.

On account of this absence of material we are unable to offer from our investigations any information about the food of this species. In this connection, the reports of others are interesting. "In captivity they have been found to feed on small frogs" (Fowler). "They prey upon insects and worms, and even attack larger creatures, when within reach" (Ditmars). "Larvæ and animal food" (Cope).

No. 7. *Amblystoma jeffersonianum* (Green). **Jefferson's Salamander.**

Jefferson's Salamander, also known as the Granulated Salamander, is recognized by its olive brown or blackish color, usually varied with pale or bluish spots. Some specimens are uniformly plumbeous. The head is small and the eyes are situated far back on it. The body is slender and bears 12 costal grooves. This species is quite variable in color and size, which ranges from 5 to 8 inches in length. There are two distinct tubercles on the sole of the foot.

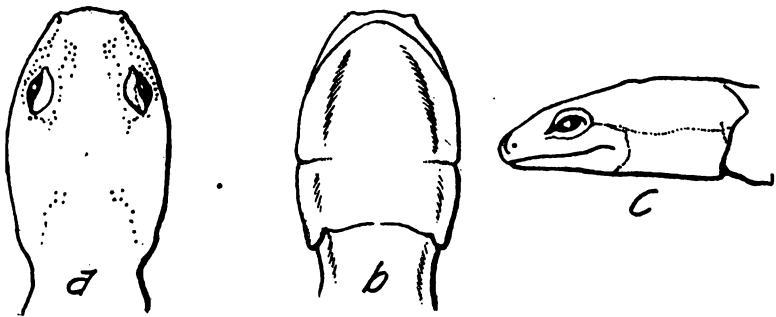


Fig. 5.—Structural characters of Jefferson's Salamander (*Amblystoma jeffersonianum*): a, dorsal view of head; b, ventral view; c, lateral view. About three-fifth times natural size.

Original Drawings, from the Office of the State Zoologist.

This form is represented in our collection by five examples from as many counties of Pennsylvania. These, as will be seen, are located in four distinct parts of the State, a fact which would indicate that the species occurs undoubtedly in adjacent, if not in all intervening counties. "It is found from Virginia to Indiana and northward; common" (Jordan).

Bedford county,	Shaffer, O. N.,	Hyndman.
Monroe county,	Gleogler, Ben.,	Tobyhanna.
Mercer county,	Beaver, R. O.,	Greenville.
Northampton county,	Davison, Prof. Alvin,	Easton.
erry county,	Brightbill, H. A.,	Marshrun.

Of the five specimens we received, the stomach of but one contained any food, and that was identified (with doubt) as snails. We find no reference in literature to the habits or food of this species. More specimens are needed for further studies.

FAMILY IV. PLETHODONTIDÆ. THE RED-BACKED SALAMANDERS.

The species of Plethodontidæ have a coarse brush of teeth situated on the parasphenoid and directed backwards. The tongue is small and attached by a central portion known as the pedicel, but is free along the margin. This is our largest family of salamanders.

STRUCTURAL KEY TO THE SPECIES OF PLETHODONTIDÆ.

A. Tongue attached by a band running from its central or posterior pedicel to the anterior margin (see Figs. 6 and 8).

a. Toes 4-4 (4 on the front feet and 4 on the hind feet) (See Fig. 6.)

a'. Brown above, snout yellow; whitish below, with ink-like spots; body short; tail slender; skin of back with depressions resembling scales; costal grooves 13. Length $2\frac{1}{2}$ inches.

No. 8. *Hemidactylum scutatum*, page 92.

b. Toes 4-5 (4 on the front feet and 5 on the hind feet.) (See Fig. 7).

a'. Costal grooves 16 to 18; plumbeous above, often with a broad, brownish red, dorsal band; belly marbled; body very slender; tail cylindric; length $3\frac{1}{2}$ inches.

No. 9. *Plethodon cinereus*, page 93.

b'. Costal grooves 14; black, usually with bluish-white blotches and specks; stout; tail rounded; length 5 to 7 inches.

No. 10. *Plethodon glutinosus*, page 96.

B. Tongue free all around; attached by central pedicel only; toes 4-5, all free (see Fig. 9).

a. Costal grooves 13 or 14.

a'. Tail scarcely as long as rest of body, rounded at base, not finned. Yellowish or purplish brown above, marked with irregular, gray blotches. Costal grooves 14; length 6 inches.

No. 11. *Gyrinophilus porphyriticus*, page 97.

b'. Tail about as long as rest of body; yellow with a dark line along each side of back; belly unspotted; costal grooves 14, rather faint; length 3 inches.

No. 12. *Splerpes bilineatus*, page 98.

c'. Tail $1\frac{1}{2}$ to 2 times as long as the rest of the body; orange yellow; back and sides with many irregular, small, black spots; median dorsal series of spots; belly spotless; length, 5 inches.

No. 13. *Spelerpes longicauda*, page 100.

b. Costal grooves 15 to 17; tail rounded at base, not keeled; vermilion red, with numerous, crowded faint dark spots; head wide; tail shorter than body; length 6 inches.

No. 14. *Spelerpes ruber*, page 101.

DISCUSSION OF THE PLETHODONTIDÆ BY SPECIES.

No. 8. *Hemidactylum scutatum* (Schlegel). The Four-toed Salamander.

As its name implies, this species has four toes on each foot. The coloration is brown above. The snout is yellow or ochraceous tinted. The body is short and whitish below, with ink-like spots; has 13 costal grooves, and the tail is slender. The total length averages $2\frac{1}{2}$ inches.

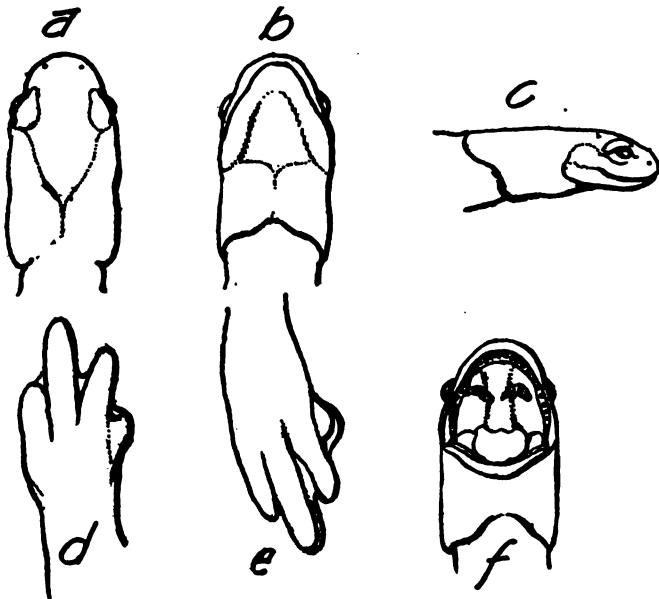


Fig. 6.—Structural characters of the Four-toed Salamander (*Hemidactylum scutatum*): a, dorsal view of head; b, ventral view; c, lateral view; d, fore foot; e, hind foot; f, ventral view of head, mouth open. About three times natural size.

Original Drawings, from the Office of the State Zoologist.



Plate III.—Dorsal view of the Hellbender (*Cryptobranchus alleganiensis*). One-fourth natural size. Photographed in the office of H. A. Surface, Economic Zoologist.



Plate IV, Fig. 1.—Dorsal view of the Blotched Salamander (*Amblystoma opacum*), showing the costal grooves. About natural size. Photographed in the office of H. A. Surface, Economic Zoologist.



Plate IV, Fig. 2.—Lateral view of the Red-backed Salamander (*Plethodon cinereus*). Slightly less than natural size. Photographed in the office of H. A. Surface, Economic Zoologist.

This species occurs throughout the entire eastern portion of the United States, but appears to be very local and rare in its distribution. We have but two specimens, which are from Wayne, Delaware County.

It is said to occur under logs in upland situations, and to be strictly terrestrial (Fowler). "Inhabits timbered regions, where it hides under logs and stones in scattered companies" (Ditmars).

Of the two specimens we received, the stomach of one contained spiders, Spring Tails, Drosophilid flies, Homopterous bugs and undetermined insects. Although this information is so limited as to be insufficient in defining the food of this species, it does give some definite insight into its diet, and proves its insectivorous habits and possibility in aiding to check an insect outbreak.

No. 9. *Plethodon cinereus* (Green). The Red-backed Salamander.

This Red-backed species is known under a variety of names, such as Gray Salamander and Dapple Salamander, all of which are suggested

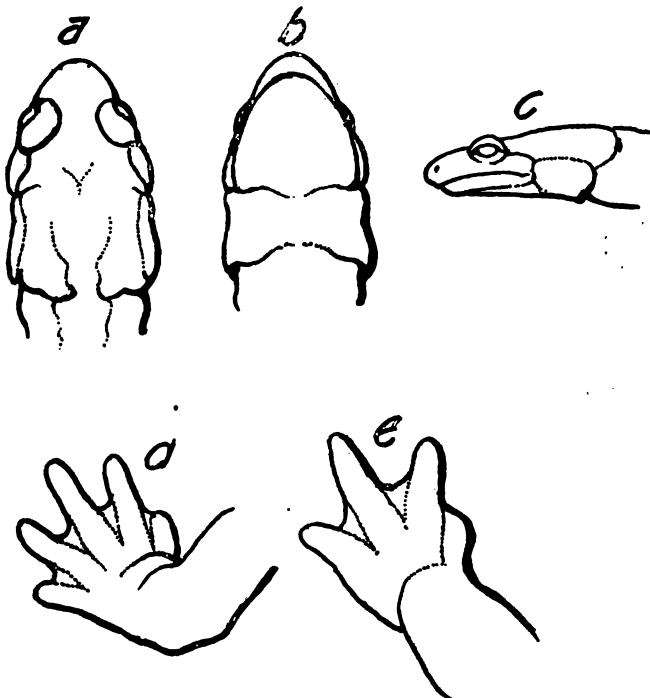


Fig. 7.—Structural characters of the Red-backed Salamander (*Plethodon cinereus*); a, dorsal view of head; b, ventral view; c, lateral view; d, hind foot, e, fore foot. About three times natural size.

Original drawings from the Office of the State Zoologist.

by its color. This is defined as plumbeous above, often with a broad, reddish, dorsal band, but it should be remembered that it is not always "red-backed." The belly is marbled; there are 16 to 18 costal grooves; the fore feet bear four toes and the hind feet five; the tail is cylindrical, and the slender body averages $3\frac{1}{2}$ inches in length.

This species occurs throughout the Eastern United States. It is common throughout Pennsylvania, as shown by the list below:

Adams county,	Barnes, W. A.,	Gettysburg.
Adams county,	MacMillan, D. K.,	Zora.
Allegheny county,	Brumbaugh, C.,	Wilkinsburg.
Allegheny county,	Couch, Witmer,	Carnegie.
Allegheny county,	Cruikshank, Dr. O. F.,	Swissvale.
Allegheny county,	Grof, J. L.,	
Beaver county,	McClelland, J. W.,	New Brighton.
Berks county,	Becker, W. D.,	Fleetwood.
Berks county,	Gruber, C. L.,	Kutztown.
Berks county,	Leibelsperger, I. H.,	Fleetwood.
Berks county,	Frets, H. W.,	Allentown.
Berks county,	Rauch, H. H.,	Joanna.
Bradford county,	Lewis, W. E.,	Rummerfeld.
Bucks county,	Bewley, A. F.,	Forest Grove.
Bucks county,	Bewley, Anna K.,	Forest Grove.
Bucks county,	Buckman, A. W.,	Doylertown.
Bucks county,	Kreiss, P. L.,	Benjamin.
Butler county,	Woodring, W. O.,	Chicora.
Cambria county,	Frank, E.,	Johnstown.
Carbon county,	Solt, W. E.,	Weissport.
Chester county,	Lawrence, John,	Coatesville.
Chester county,	Parson, O. S.,	Devon.
Chester county,	Robinson, Miss M.,	Paoli.
Clarion county,	Arnold, F. M.,	Clarion.
Cumberland county,	Zool. Office Attaches,	Enola.
Cumberland county,	Zool. Office Attaches,	Camp Hill.
Dauphin county,	Anderson, Chas.,	New Cumberland.
Dauphin county,	Carruthers, D.,	Harrisburg.
Dauphin county,	Good, E. G.,	Harrisburg.
Dauphin county,	MacMillan, D. K.,	Dauphin.
Dauphin county,	Solt, N. E.,	Weissport.
Dauphin county,	Zool. Office Attaches,	Rockville.
Delaware county,	Dickson, W. C.,	Wayne.
Delaware county,	Hoopes, P. R.,	Wayne.
Delaware county,	Satterthwaite, O. P.,	Wawa.
Erie county,	Gilbert, S. W.,	Waterford.
Franklin county,	Hardy, John Y.,	Mont Alto.
Franklin county,	DeLong, C. Aubrey,	Mont Alto.
Fulton county,	Jackson, Robt. E.,	McConnellsburg.
Huntingdon county,	Swope, I. P.,	Huntingdon.
Indiana county,	Whehrle, R. W.,	Indiana.
Lancaster county,	Eby, D. H.,	Mt. Joy.
Lancaster county,	Mayer, Geo. C.,	Elizabethtown.
Lancaster county,	Mayer, Dr. I. H.,	Willow Street.
Lebanon county,	Bassler, Harvey,	Myerstown.
Lebanon county,	Kreider, A. S.,	Annaville.
Luzerne county,	Campbell, E. W.,	Wilkes-Barre.
Lycoming county,	Spencer, Douglas,	Williamsport.
Monroe county,	Allegar, J. L.,	Shawnee.
Montgomery county,	Freed, J.,	Perkasie.
Montgomery county,	King, Helen D.,	Bryn Mawr.
Montgomery county,	Lutz, Frank,	Morrisstown.
Montgomery county,	Neithamer, Fred,	Ringing Rock.
Montgomery county,	Rutter,	Perkasie.
Montgomery county,	Schneider, H. W.,	Pottstown.
Montour county,	West W. O. G.,	Danville.
Northampton county,	Donnelly, Chas.,	Easton.
Northampton county,	Greene, John W.,	Easton.
Northampton county,	King, Wilbur L.,	Bethlehem.
Northampton county,	Kinney, Ira L.,	Portland.
Northampton county,	Richards, Chas.,	Easton.
Perry county,	Brightbill, H. A.,	Marshrun.
Perry county,	Shumaker, Alton J.,	Blain.
Philadelphia county,	Keeney, S. D.,	Philadelphia.
Philadelphia county,	Miller, R. F.,	Frankford.
Philadelphia county,	Onderdonk, Elmer,	Philadelphia.
Tioga county,	Huislander, Harry P.,	Mainesburg.
Warren county,	Cartwright, E. W.,	Grand Valley.
Warren county,	Whitcomb, Miss F.,	Corydon.
Wayne county,	Bullock, W. H.,	Honesdale.
Wyoming county,	Wells, R. C.,	Meshoppen.
York county,	Donleay, LeRoy,	Etters.
York county,	MacMillan, D. K.,	Pigeon Hills.
York county,	Resser, E. S.,	York.

It is entirely terrestrial, and is said never to occur in water but lives under logs and stones in forests. Some authors report having found it in open fields. It is nocturnal and very active, quickly disappearing among the decaying vegetation or other loose material when disturbed in its hiding place.

The eggs are deposited under stones, moss, on bark of decaying trees, in clusters of five to ten or more. The young, which are provided with gills, which they lose in a few days, often resemble the parents very closely in markings.

Its food is reported to consist of "insects and their larvæ" (Fowler, Cope), and small snails (Smith). The analysis, in our laboratory, of the stomach contents of 260 specimens showed principally snails, earthworms, spiders, mites, thousand-legged "worms," insect larvæ and adult insects, of which ants formed a large part. This shows its adaptability to different surroundings and food conditions.

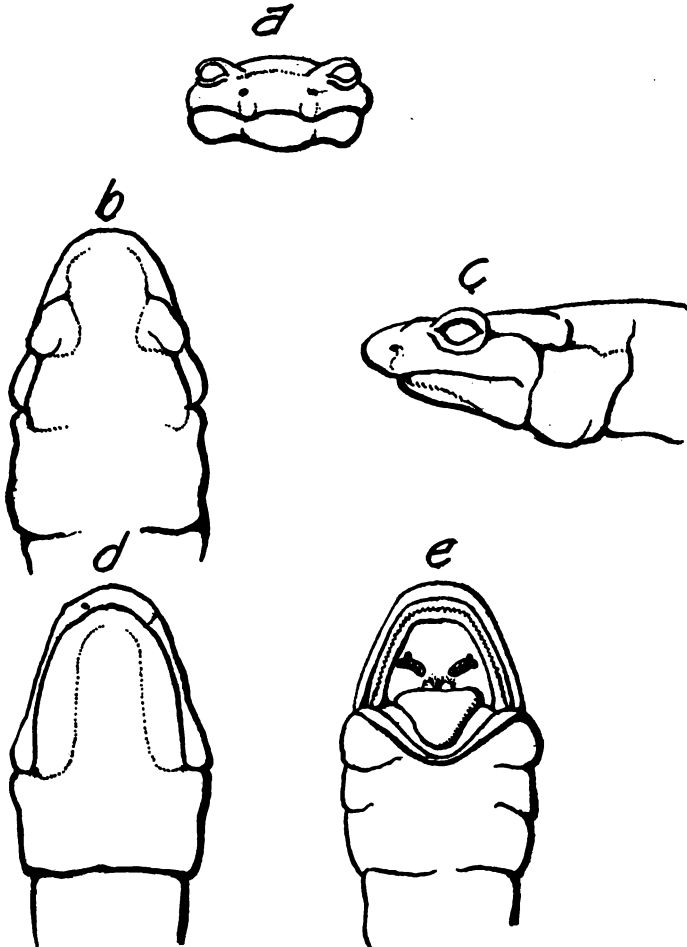


Fig. 8.—Structural characters of the Slimy Salamander (*Plethodon glutinosus*): a, front view of head; b, dorsal view; c, lateral view; d, ventral view; e, same, mouth open. About three times natural size.

Original drawings from the Office of the State Zoologist.

No. 10. *Plethodon glutinosus* (Green). The Slimy Salamander.

This common species is known by several names such as Slimy, Sticky, Blue-spotted, and Gray-spotted Salamander. It must not be inferred from its name that it is the only one that is "slimy." The general color is black, blotched and specked with bluish-white. The stout body has 14 costal grooves, and measures from 5 to 7 inches in length. The tail is rounded, and, unlike the preceding species, the inner fingers are well developed.

It is found throughout the Eastern United States (Jordan). In Pennsylvania it is justly to be regarded as one of our commonest species, as shown by our collection, which contains 170 examples from 32 counties:

Adams county,	MacMillan, D. K.,	Zora.
Allegheny county,	Atkinson, Dr. D. A.,	Westville.
Allegheny county,	Brumbaugh, C. T.,	Wilkinsburg.
Allegheny county,	Cruikshank, O. F.,	Swissvale.
Allegheny county,	Van Ostrand, H. T.,	Crafton.
Armstrong county,	McGinnis, W.,	Parkers Landing.
Beaver county,	Fiddler, T. J.,	New Brighton.
Beaver county,	Mansfield, I. F.,	Beaver.
Berks county,	Gruber, O. L.,	Kutztown.
Berks county,	Miller, H. R.,	Robesonia.
Berks county,	Preston, A. W.,	Wernersville.
Butler county,	Gulson, T. A.,	Chicora.
Cambria county,	Brubaker, F. M.,	Johnstown.
Cambria county,	Seaman, E. S.,	Willmore.
Centre county,	Goss, A.,	Port Matilda.
Cumberland county,	Zool. Office Attaches,	Enola.
Dauphin county,	Buffington, N. E.,	Lykens.
Dauphin county,	Frew, Thos.,	Williamstown.
Dauphin county,	Good, E. G.,	Harrisburg.
Dauphin county,	Keboch, F. D.,	Williamstown.
Dauphin county,	Werdt, Elmer,	Williamstown.
Dauphin county,	Urich, D. C.,	Penbrook.
Dauphin county,	Zool. Office Force,	Dauphin.
Dauphin county,	Zool. Office Force,	Rockville.
Erie county,	Mixer, E. M.,	Union City.
Fayette county,	Lange, W. H.,	Belle Vernon.
Forest county,	Jenson, R. E.,	Starr.
Franklin county,	DeLong, C. A.,	Mont Alto.
Franklin county,	Hardy, John,	Mont Alto.
Franklin county,	Hopkins, E. D.,	Mercersburg.
Fulton county,	Jackson, R. L.,	McConnellsburg.
Fulton county,	Palmer, A. O.,	Wartfordsburg.
Huntingdon county,	Black, J.,	Huntingdon.
Indiana county,	Montgomery, D. E.,	Shelata.
Indiana county,	Wehrle, R. W.,	Indiana.
Jefferson county,	Moore, A. B.,	Port Matilda.
Lycoming county,	Spencer, Douglas,	Williamsport.
Monroe county,	Allegar, I. L.,	Shawnee.
Montgomery county,	Gettsbalk, O. S.,	Rahns.
Montour county,	West, H. K.,	Danville.
Montour county,	West, Mrs. G. B.,	Danville.
Northampton county,	King, W. S.,	Bethlehem.
Northampton county,	Richards, C.,	Easton.
Perry county,	Brigutbill, H. A.,	Marshrun.
Perry county,	Showalter, C. E.,	Landisburg.
Perry county,	Shwaker, A. J.,	Blain.
Somerset county,	Kitchman, W. H.,	Meredale.
Susquehanna county,	Gere, C. E.,	Kingsley.
Union county,	Grove, M. J.,	Millmont.
Venango county,	Sims, Geo. B.,	Cherrytree.
Washington county,	Couch, Merle,	Canonsburg.
Washington county,	Couch, Jos.,	Canonsburg.
Westmoreland county,	Tomson, Jas.,	Vandergrift.
Wyoming county,	Buer, Gilbert,	Meshoppen.
Wyoming county,	Swartzwood, Ira,	Falls.
York county,	Resser, E. S.,	York.
York county,	Zool. Office,	Peach Bottom.

It prefers hilly or mountainous country, and especially rocky situations, where it likes to seclude itself under stones, among leaf mold,

and fallen logs. It is chiefly terrestrial in its habits. When handled it attempts to bite, and exudes a slimy or sticky mucus through the pores of the skin. It is not venomous, but this exudation is acrid or offensive to animals that would take it into their mouths.

It is implied by Fowler that this species lays its eggs in damp places on land and the young quickly lose the branchiæ, or gills, as does *Plethodon cinereus*.

Of 170 specimens received and examined, the stomachs of 125 contained food. This consisted of earthworms, snails, spiders, thousand-legged "worms," and insects and their larvæ. A more detailed idea of the insect food can be derived from the table of stomach contents.

No. 11. *Gyrinophilus porphyriticus* (Green). The Purple Salamander.

The so-called Purple Salamander is yellowish or purplish brown above, irregularly blotched with gray. The head is broad, and the tail, which is rounded at the base, is not finned. There are 14 costal grooves. In this genus (*Gyrinophilus*) and the following one (*Speleperpes*) the tongue is free all around, being attached by the central pedicel only. The fore feet have four toes and the hind feet, five. Adults average 6 inches in length.

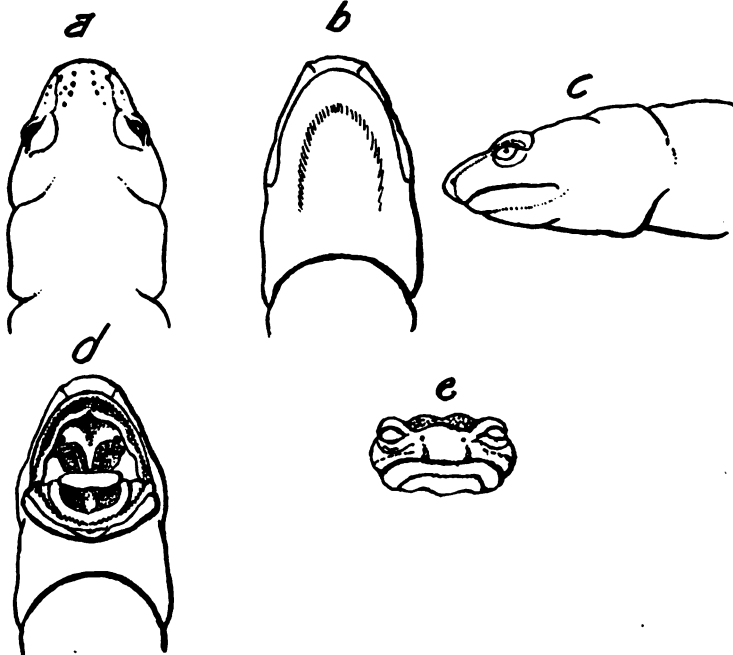


Fig. 9.—Structural characters of the Purple Salamander (*Gyrinophilus porphyriticus*): a, dorsal view of head; b, ventral view; c, lateral view; d, ventral view, mouth open; e, front view. About natural size.

Original drawings from the Office of the State Zoologist.

The species is found in the eastern section of the United States, where it prefers mountainous situations. Our collection consists of 71 specimens, from 27 counties, as follows:

Allegheny county,	Cruikshank, Dr. O. F.,	Swissvale.
Allegheny county,	Grof, J. L.,	Pittsburgh.
Armstrong county,	Beers, F. P.,	Dayton.
Berks county,	Gruber, C. T.,	Kutztown.
Bradford county,	Warburton, G. W.,	Granville Summit.
Cambria county,	Seaman, A. F.,	Wilmore.
Carbon county,	Solt, N. E.,	Weissport.
Clearfield county,	Hard, W. E.,	Lajose.
Cumberland county,	Zool. Office Force,	Enola.
Dauphin county,	Host, Edna,	Williamstown.
Dauphin county,	MacMillan, D. K.,	Dauphin.
Dauphin county,	Sober, Miss,	Harrisburg.
Dauphin county,	Williamson, H.,	Harrisburg.
Fulton county,	Jackson, R. L.,	McConnellsburg.
Indiana county,	Smith, H. E.,	Indiana.
Indiana county,	Wehrle, R. W.,	Indiana.
Jefferson county,	Schuckers, W. H.,	Reynoldsville.
Jefferson county,	Mitchell, T. A.,	Punxsutawney.
Junata county,	Hakenberger, Melissa,	Mifflintown.
Lehigh county,	Pretz, Harold W.,	Allentown.
Lycning county,	Wanner, W. G.,	Calvert.
Montour county,	West, Mrs. O. G.,	Danville.
Northumberland county,	Foulk, H. P.,	Asherton.
Perry county,	Brightbill, H. A.,	Marshrun.
Perry county,	Collender, Geo.,	Duncannon.
Perry county,	Irvine, W. T.,	Loyaville.
Philadelphia county,	Miller, Richard,	Bustleton.
Potter county,	Beebe, Miss A.,	Odin.
Potter county,	Dietterich, C. E.,	Westpike.
Susquehanna county,	Bumel, T. B.,	Anburn.
Tioga county,	Mulford, E. R.,	Wellsboro.
Warren county,	Hartzell, F. B.,	Warren.
Washington county,	McCurey, W. T.,	Crothers.
Wayne county,	Bullock, W. H.,	Honesdale.
Wayne county,	Dix, A. E.,	Island Pond.
Wayne county,	Hall, R. W.,	Waymart.
Westmoreland county,	Book, T. G.,	New Alexander.
Westmoreland county,	Myers, R. I.,	Welty.
Wyoming county,	Swartzwood, Ira,	Falls.

It is aquatic and prefers still water such as is found in swamps and springs. It occurs also in "moist land under logs and in damp woods." (Smith). Prof. Cope states, "This is the only one of our eastern salamanders which attempts self defense. It snaps fiercely but harmlessly, and throws its body into contortions."

Of a confined specimen W. H. Smith writes (in Geological Survey of Ohio), "it appeared healthy for a year, and lived on flies." Of 71 stomachs examined in the laboratory of the Economic Zoologist, 26 contained food. This was made up of earthworms, snails, undetermined crustacea, spiders, thousand-legged "worms", fly larvæ and ground beetles principally. This is the first published statement that is definite in regard to the food of this species.

No. 12. *Spelerpes bilineatus* (Green). The Two-lined Salamander.

The specific name, "*bilineatus*," (meaning two-lined) is applied to this species for the same reason as the common name, namely, the yellow body is marked by a dark line extending along each side of

the back. The under parts are unspotted. The body bears 14 faint costal grooves. The total length is about 3 inches, of which the tail forms one-half.

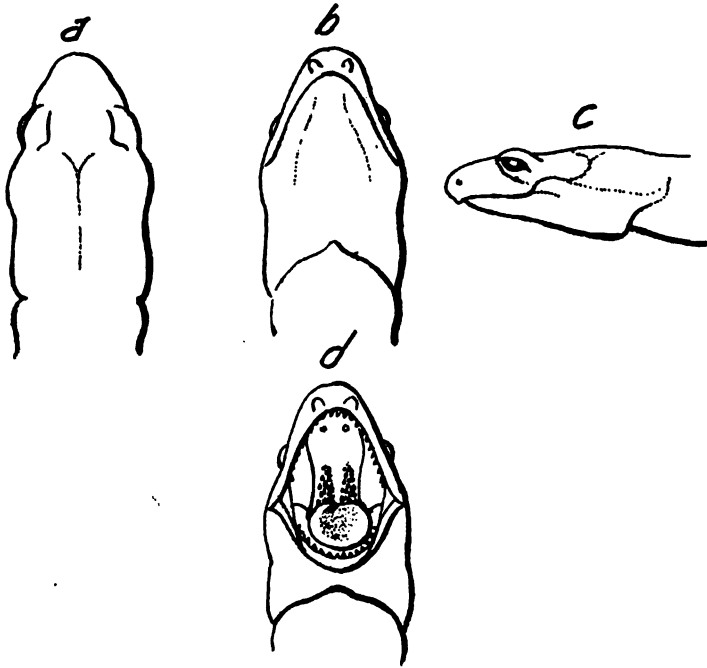


Fig. 10.—Structural characters of the Two lined Salamander (*Spelerpes bilineatus*): a, dorsal view of head; b, ventral view; c, lateral view; d, ventral view, mouth open. About three times natural size.

Original drawings from the Office of the State Zoologist.

The Two-lined Salamander occurs from Maine to Wisconsin and southward (Jordan); it is very abundant in Pennsylvania and extends its range with decreasing numbers to Maine (Cope). Nineteen counties contributed specimens to our collection, as follows:

Adams county,	MacMillan, D. K.,	Zora.
Bedford county,	Lee, R. F.,	Bedford.
Berks county,	Schoener, R. E.,	Stouchsburg.
Chester county,	Paxson, O. G.,	Devon.
Dauphin county,	Zool. Office Attaches,	Highspire.
Franklin county,	Hardy, Jno.,	Mont Alto.
Indiana county,	Wehrle, R. W.,	Indiana.
Lancaster county,	Mayer, Dr. I. H.,	Willow Street.
Lebanon county,	Bassler, Harvey,	Myerstown.
Lehigh county,	Pretz, Harold W.,	Allentown.
Mercer county,	G. High School,	Greenville.
Montgomery county,	King, H. D.,	Bryn Mawr.
Northampton county,	King, Wilbur,	Bethlehem.
Perry county,	Brightbill, H. A.,	Marshrun.
Philadelphia county,	Showalter, C. E.,	Ladysburg.
Philadelphia county,	Harker, H.,	Westtown.
Susquehanna county,	Onderdonk, Elmer,	Philadelphia.
Tioga county,	Shaver, K.,	Ararat.
Warren county,	Andrews, F. S.,	Wellsboro.
York county,	Hartzell, F. B.,	Warren.
	MacMillan, D. K.,	Pigeon Hills.

This species is occasionally found under stones in decaying matter in woodlands and prefers moist conditions. Shallow depths of water,

such as brooks, are the places most favorable for it. When the concealing stones are removed, the exposed creature becomes very active and hurriedly wriggles under a new cover.

The larvæ are aquatic, and when practically the size of adults, their metamorphosis generally takes place, and they become air-breathing forms.

Reference to the Table of Stomach Contents shows that we found the food of the Two-lined Salamander to consist of spiders, mites, thousand-legged "worms," undertermined insects, Hemiptera, Homoptera, flies, beetles and their larvæ, Rove Beetles or Staphylinidæ, Chalcis flies, and an undetermined salamander. This is an extensive proven list, showing remarkable variation and adaptability of the species to a variety of conditions.

No. 13. *Spelerpes longicauda* (Green). The Cave or Long-tailed Salamander.

The Cave Salamander is very conspicuous because of its orange yellow color, which is varied on the back and sides with many irregu-

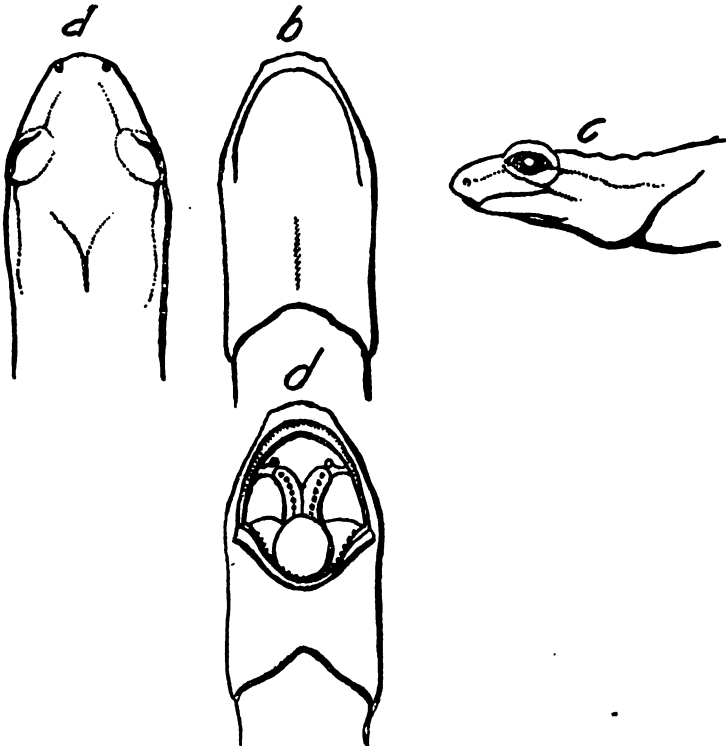


Fig. 11.—Structural characters of the Cave or Long-tailed Salamander (*Spelerpes longicauda*): a, dorsal view of head; b, ventral view; c, lateral view; d, ventral view, mouth open. About three times natural size.

Original drawings from the Office of the State Zoologist.



Plate V, Fig 1.—Dorsal view of the Spotted Salamander (*Amblystoma punctatum*), showing the costal grooves. About natural size. Photographed in the office of H. A. Surface, Economic Zoologist.



Plate V, Fig. 2.—Dorso-lateral view of the Spotted Salamander (*Amblystoma punctatum*). About natural size. Photographed in the office of H. A. Surface, Economic Zoologist.



Plate VI, Fig. 1.—Dorso-lateral view of the Slimy Salamander (*Plethodon glutinosus*). About three-fourths natural size. Photographed in the office of H. A. Surface, Economic Zoologist



Plate VI, Fig. 2.—Dorsal view of the Purple Salamander (*Gyrinophilus porphyriticus*), showing the costal grooves. Slightly larger than natural size. Photographed in the office of H. A. Surface, Economic Zoologist.

lar, small, black spots, of which there is a median dorsal series. The belly is spotless, while the keeled tail is spotted or barred with black. Adults average 5 inches in length. As with other species of the genus *Spelerpes*, there are about 13 or 14 costal grooves.

It is found in the United States from Maine to Minnesota and southward (Jordan), and is pretty well distributed over Pennsylvania. Our collection includes specimens from 18 counties, as follows:

Adams county,	MacMillan, D. K.,	Zora.
Allegheny county,	Cruikshank, Dr. O. F.,	Swissvale.
Allegheny county,	Walker, Dr.,	Carnegie.
Berks county,	Grum, W. H.,	Hamburg.
Berks county,	Hartline, E. H.,	Springville.
Bradford county,	Green, C. N.,	Troy.
Cambria county,	Brubaker, F. M.,	Johnstown.
Carbon county,	Solt, N. E.,	Wellspport.
Dauphin county,	Sober, Miss.,	Harrisburg.
Dauphin county,	Zool. Office Attaches,	Dauphin.
Fulton county,	Morton, W. D.,	McConnellsburg.
Indiana county,	Baker, H. B.,	Indiana.
Indiana county,	Brumbaugh, L.,	Wilkinsburg.
Lancaster county,	Heiserman, J. J.,	Lititz.
Lawrence county,	Clark, Dr. R. B.,	Volan.
Lebanon county,	Bassler, H.,	Myerstown.
Lebanon county,	Keath, J. M.,	Schaeferstown.
Luzerne county,	Campbell, E. W.,	Pittston.
Montour county,	West, W. O. G.,	Danville.
Somerset county,	Bowman, D. H.,	Mance.
Verango county,	Bean, T. S.,	Emlenton.
Washington county,	Couch, Jos.,	Canonsburg.
Washington county,	Couch, Jos.,	Hickory.

The Cave Salamander is so called because it is found abundantly in certain caves, notably in Indiana and Kentucky. It has a strong liking for such situations, and in their absence contents itself with living in fissures in rocks or in rocky ground. These afford damp situations especially suitable to it. It is not an active creature, and is said to be rather nocturnal in its habits.

Our records show that of the 52 specimens we received, the stomachs of 45 contained food. This consisted of spiders, mites, pseudo-scorpions, thousand-legged "worms", various forms of insects, and vegetable matter, such as grass. The reader can gain a more detailed idea of the nature of the insect food by consulting the table on page 134.

No. 14. *Spelerpes ruber* (Daudin). The Red Salamander. -

The Red Salamander is known by a great variety of common names, such as Red Triton, Red Lizard, and Spring Lizard. The incorrect term of "lizard" is perhaps more often applied to this species than to any other. The error of the application has been shown in the introduction.

This creature is vermilion red in color, with numerous crowded, faint, dark spots. The head is wide and the tail is as long as the body. Adults reach a length of six inches.

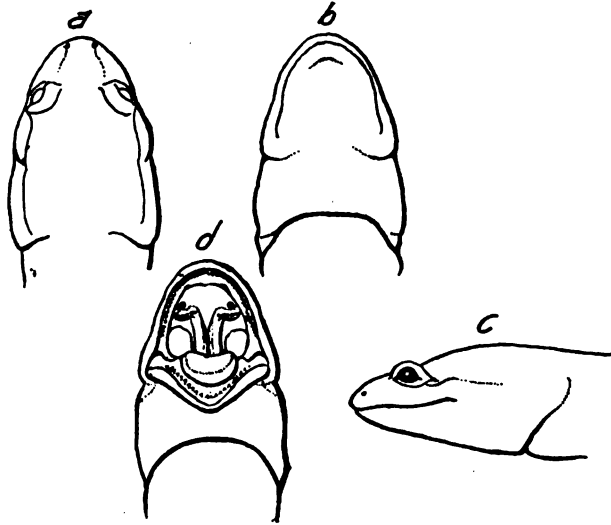


Fig. 12.—Structural characters of the Red Salamander (*Spelerpes ruber*): a, dorsal view; b, ventral view; c, lateral view; d, ventral view, mouth open. About 1 1-3 times natural size.

Original drawings from the Office of the State Zoologist.

It occurs from Maine to Nebraska and southward (Jordan). Prof. Cope has described a subspecies, *Spelerpes ruber montanus*, in which the tail is as long as the body, and in which is lacking the dark bar across the eye, usually present in the typical species. This subspecies is distributed from Pennsylvania to South Carolina. That the Red Salamander is common is shown by the following list of specimens received by this office:

Allegheny county,	Cruikshank, Dr. O. F.,	Swissvale.
Berks county,	Althouse, D. A.,	Calcium.
Berks county,	Bolan, D. W.,	Robesonia.
Berks county,	Boyer, H. M.,	Reading.
Berks county,	Gruber, C. J.,	Kutztown.
Berks county,	Grun, W. H.,	Hamburg.
Berks county,	Rittenhouse, J. S.,	Loraine.
Bucks county,	Atkinson, J. W.,	Buckingham.
Bucks county,	Haines, Walter,	Richhill.
Bucks county,	Van Sant, Belle,	George School.
Cambla county,	Frank, E.,	Johnstown.
Carbon county,	Solt, W. E.,	Wellsport.
Centre county,	Wasson, R. W.,	Lemont.
Centre county,	First, Walter,	Bellefonte.
Cumberland county,	Ebersole, C. S.,	Mechanicsburg.
Cumberland county,	Zool. Office Attaches,	Enola.
Dauphin county,	Surface, H. B.,	Mechanicsburg.
Dauphin county,	Braddorf, Geo.,	Williamstown.
Dauphin county,	Ruffington, H. E.,	Lichens.
Dauphin county,	Curtis, Fred.,	Williamstown.
Dauphin county,	Fauber, D. W.,	Progress.
Dauphin county,	Hipple, Jas.,	Middletown.
Dauphin county,	Keboch, F. D.,	Williamstown.
Dauphin county,	Kirch, H.,	Williamstown.
Dauphin county,	MacMillan, D. K.,	Rockville.
Dauphin county,	Naugle, R.,	Dauphin.
Delaware county,	Harum, David,	Swarthmore.
Erie county,	Mixer, E. M.,	Waterford.
Franklin county,	Daque, W. F.,	Mont Alto.
Franklin county,	Delong, C. A.,	Mont Alto.
Franklin county,	Swall, L. B.,	Marion.
Indiana county,	Baker, H. B.,	Indiana.
Indiana county,	Wehrle, R. W.,	Indiana.
Lebanon county,	Bolan, Jno.,	Onset.

Lebanon county,	Derickson, S. H.,	Annaville.
Lebanon county,	Stiner, W. E.,	Myerstown.
Lehigh county,	Kern, D. N.,	Allentown.
Luzerne county,	Fink, H. L.,	Shickshinny.
Lycoming county,	Geddes, J. M.,	Williamsport.
Mercer county,	Annon, Grace,	Greenville.
Montgomery county,	Gettsbalk, O. S.,	Rahns.
Montgomery county,	King, H. D.,	Bryn Mawr.
Montour county,	West, Mrs. G. P.,	Danville.
Perry county,	Brightbill, H. A.,	Marysrun.
Schuylkill county,	Zool. Office Attaches,	Marysville.
Snyder county,	Moore, B. S.,	Auburn.
Susquehanna county,	Apple, P. A.,	Middleburg.
Warren county,	Brown, N. S.,	Springville.
Wayne county,	Simpson, R. B.,	Warren.
Wayne county,	Bullock, W. H.,	Honesdale.
York county,	Smith, T. L.,	Orson.
	Gable, Jas. B.,	Stewartstown.

The Red Salamander is sometimes found under the bark of fallen trees, where there is dampness, but it prefers to live under flat stones in small, clear, cold streams or in the adjacent pools. Then, too, it is found at springs in more elevated situations and, as this is the species frequently found at springs, it is called by many the "Spring Lizard." It is popularly, but wrongly, considered venomous.

"The eggs are deposited early in spring in the deeper pools of brooks" (Ditmars).

The food found in 59 stomachs consisted of earthworms, snails, slugs, spiders, thousand-legged "worms", numerous forms of insects and their larvæ, and plant material. For a detailed idea refer to the table.

Authors offer the following on the food of the Red Salamander: "They feed largely on insects, and are perfectly harmless" (Fowler). "Their food consists of insects." (Cope). "Mainly small worms, though Hallowell found in the stomach of one a coleopterous insect and the tail and posterior limb of a salamander" (Smith).*

FAMILY V. DESMOGNATHIDÆ. THE DUSKY SALAMANDERS.

This family includes those salamanders in which there are teeth on the parasphenoid; the tongue is moderate in size and largely free. Each of the feet is provided with five toes. However, it is very difficult to distinguish the members of this family from those of the preceding by the use of external characters, and in a publication of this kind it is desirable to avoid technicalities as much as possible. In such a case as this, more attention should be given to the descriptions of the species as a means of determination. The three known species of this family all occur within the limits of this Commonwealth.

STRUCTURAL KEY TO THE SPECIES OF DESMOGNATHIDÆ.

A. Costal grooves 13 or 14; color brown.

a. Tail rather cylindrical and tapering; underparts unspotted;

**Spelerpes montanus* Cope differs from *Spelerpes ruber* (Daudin), in that the tail is as long as the body and there is no dark line across the eye. This species, we are informed by Dr. Leonhard Stejneger, of the United States National Museum, is represented in the collection of the Smithsonian Institution by one Pennsylvania specimen collected at Carlisle by Prof. S. F. Baird.

brownish yellow, with a brownish shade on each side; a yellow band extending along the back, which has a few spots; length, 3 inches.

No. 15. *Desmognathus ochrophæa*, page 104.

- b. Tail flattened and keeled; marked below; brown above, with gray or purplish spots or shades; tail as long as head and body; length, 4 inches.

No. 16. *Desmognathus fusca*, page 104.

- B. Costal grooves 12; tail flattened and keeled; color black. Uniform black, stout body; length, 6 inches.

No. 17. *Desmognathus nigra*, page 106.

DISCUSSION OF THE DESMOGNATHIDÆ BY SPECIES.

No. 15. *Desmognathus ochrophæa* (Cope). **The Mountain Salamander.**

The Mountain Salamander is brownish yellow, with a shading of brown on each side, and a dorsal band of a yellowish tint. The back is marked sparsely with spots, while the under parts are unspotted. In the male the lower jaw is toothless behind. Adults attain a length of three inches.

It is found from New York to Georgia, in the mountains" (Jordan). It is "common in the Adirondacks and the mountains of Northern Pennsylvania, whence it extends southward into the mountain chains of Virginia and North Carolina" (Ditmars).

Of its habits authors offer the following: "In habits it appears to be quite terrestrial, living under decaying logs, or burrowing its way under their bark" (Ditmars). "It occurs under the bark of every fallen log of hemlock and in the debris of dark damp forests of the North. Never saw one in the water of streams or river banks" (Cope).

Practically nothing is said in literature of its reproduction, except that Prof. Cope mentions having found about twenty eggs in a specimen. In like manner nothing is offered with reference to its food, but it is no doubt insectivorous and similar to the following.

No. 16. *Desmognathus fusca* (Raf.) **The Dusky Salamander.**

As in the case of other common species, this form is known by several common names, such as Brown Newt, Yellow Salamander and Black "Water-Lizard." Its name *fusca* signifies "brown," which is the prevailing color of the upper parts of the body. This color is broken by gray or purplish spots or shades which become black with

age. The body is marbled below. The length averages four inches, of which the tail occupies one-half. Prominent eyes are a feature of this species.

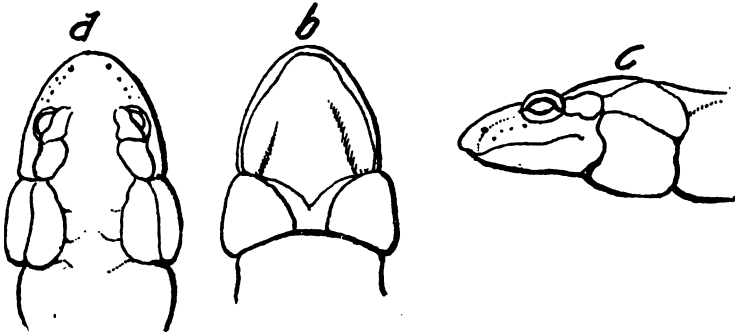


Fig. 13.—Structural characters of the Dusky Salamander (*Desmognathus fusca*): a, dorsal view of head; b, ventral view; c, lateral view. About twice natural size.

Original Drawings, from the Office of the State Zoologist.

It is distributed over the United States from "Massachusetts to Ohio and southward" (Jordan). We have examples from thirty-two counties, a fact which shows this species is well distributed in our Commonwealth. The list received is as follows:

Adams county.	MacMillan, D. K.,	Zora.
Allegheny county.	Brumbaugh, C. L.,	Wilkinsburg.
Allegheny county.	Couch, W.,	Carnegie.
Allegheny county.	Cruikshank, Dr. O. F.,	Swissvale.
Allegheny county.	Eakman, Irene,	Munhall.
Beaver county.	Mausfield, J. F.,	Beaver.
Berks county.	Nuthamer, E. F.,	Reading.
Berks county.	Schoener, K. E.,	Stouchsburg.
Bradford county.	Hoffman, J. H.,	New Albany.
Rucks county.	Atkinson, W.,	Buckingham.
Rucks county.	Keeney, S. D.,	Yardley.
Cambria county.	Brubaker, F. M.,	Johnstown.
Cambria county.	Seaman, A. F.,	Wilmore.
Carbon county.	Solt, N. E.,	Weissport.
Centre county.	Workman, L. V.,	State College.
Clearfield county.	Black, J. T.,	Glenhope.
Crawford county.	Hanks, A. J.,	Cochranstown.
Cumberland county.	Zool. Office Attaches,	Camp Hill.
Cumberland county.	Zool. Office Attaches,	Enola.
Dauphin county.	Delbler, Mark,	Berrysburg.
Dauphin county.	Jones, Jas.,	Williamstown.
Dauphin county.	Kirchoff, H.,	Williamstown.
Dauphin county.	MacMillan, D. K.,	Peters Mountain.
Dauphin county.	MacMillan, D. K.,	Dauphin.
Dauphin county.	Meredith, H. L.,	Harrisburg.
Dauphin county.	Phelps, Anson,	Harrisburg.
Dauphin county.	Williamson, H.,	Harrisburg.
Dauphin county.	Rubendale, L. F.,	Williamstown.
Dauphin county.	Office Attaches,	Rockville.
Dauphin county.	Office Attaches,	Camp Hill.
Delaware county.	Dickson, W. C.,	Wayne.
Franklin county.	Hopplin, E. D.,	Mercersburg.
Franklin county.	Hardy, J. J.,	Mont Alto.
Franklin county.	Roberts, I. G.,	Mont Alto.
Fulton county.	Jackson, R. L.,	McConnellsburg.
Fulton county.	Spade, G. F.,	Emmaville.
Huntingdon county.	Stowe, J. P.,	Huntingdon.
Indiana county.	Wehrle, R. W.,	Indiana.
Indiana county.	Smith, H. E.,	Indiana.
Indiana county.	Montgomery, D. E.,	Shelocta.
Lehigh county.	Mattern, E. S.,	Allentown.
Lehigh county.	Pretz, H. W.,	Allentown.
Lycoming county.	Knotts, Dr. I. D.,	Darlstown.
Lycoming county.	Van Housen, R.,	Williamsport.
Montgomery county.	King, Helen D.,	Bryn Mawr.
Montgomery county.	Lutz, F.,	Norristown.

Montgomery county,	Miller, W.,	Norristown.
Montgomery county,	Paget, M.,	Norristown.
Montour county,	West, Mrs. G. F.,	Danville.
Northampton county,	Green, John,	Easton.
Northampton county,	King, W. L.,	Bethlehem.
Northampton county,	Kluney, I. L.,	Portland.
Perry county,	Brightbill, H. A.,	Marshrun.
Perry county,	James, W. F.,	Marshrun.
Pike county,	Beebe, Miss G. A.,	Odin.
Toga county,	Taylor, G. L.,	Wellsboro.
Venango county,	McGinnis, H. H.,	Emleton.
Venango county,	Slus, Geo. B.,	Cherrytree.
Warren county,	Simpson, R. B.,	Warren.
Washington county,	Couch, Jos.,	Canonsburg.
Washington county,	Couch, Jos.,	Hickory.
Washington county,	Couch, Merle,	Hickory.
Washington county,	Leug, W. W.,	Washington.
Washington county,	McCreary, W. L.,	Crothers.
Wayne county,	Bullock, W. H.,	Honedale.
Westmoreland county,	Myers, R. I.,	Welty.
York county,	Zool. Office,	Peach Bottom.
York county,	MacMillan, D. K.,	Pigeon Hills.
York county,	Kopp, Chas.,	York New Salem.
Ohio,	Slus, R. T.,	Jefferson, Ohio.

The Brown Salamander is especially fond of concealment under stones in damp situations on hillside or mountain-side, or in the pools and swift shallow brooks in valleys. Decaying vegetable matter also affords suitable concealment. It is a very active and vigorous species. When brought to light it displays this activity well, and so promptly does it obtain shelter that it is one of the most difficult species to capture.

The eggs, when deposited, are attached by an albuminous thread, forming a structure somewhat resembling a string on which beads are distributed at intervals. It is said that one of the parents wraps this string about the body and remains in a comparatively dry spot for protection (Ditmars). The larvæ are frequently taken in mud and among rank aquatic vegetation. "It is possible, in consideration of the marked nocturnal habits of this species, that the female may leave the egg-mass during the night, returning to it by day" (Wilder).

Of the 521 stomachs examined 235 contained food. This consists of earth worms, snails, slugs, spiders, mites, insects and their larvæ (see table at end of bulletin), and vegetable matter. Nothing definite has ever before been published concerning the food of this species.

No. 17. *Desmognathus nigra* (Green). The Black Salamander.

This salamander is very distinct in that the stout body is uniformly black. Adults average six inches in length.

It is found from "Pennsylvania to Illinois and southward" (Jordan): "so far as known, it is confined to the Allegheny ranges from Pennsylvania southward" (Cope). The habitat is limited to cool, dark retreats, such as are found in the ravines and springs in the depths of mountain forests.

The Black Salamander is difficult to capture, as it rapidly seeks shelter under stones. Of its habits, reproduction and food practically nothing is known. We have no specimens and invite contributions.

FAMILY VI. PLEURODELIDÆ. THE NEWTS.

Unlike the members of the preceding family, those of the *Pleurodelidæ* lack teeth in the parasphenoid. The teeth of the palatine bones are in two series, which diverge backward. The tongue in our species is thick, oval, and attached by practically the entire under surface.

No. 18. *Diemictylus viridescens* (Raf.) The Newt.

This abundant salamander is variously known as the Newt, Evet, Eft, Red Eft, Red Evet, "Red Lizard," "Water Lizard," Spotted Triton, "Small Red Lizard," "Yellow Lizard," "Yellow-bellied Lizard," Water Newt, "Mountain Lizard," "Fire Lizard," "Rain Lizard," Crimson-spotted Triton, "Speckled Lizard," "Green Lizard," and Green Newt.

It is described as olive green or reddish above and lemon yellow below. Each side usually bears a row of several rather large, scarlet spots or dots each surrounded by a black ring. Along the back there extends a pale streak. The belly is marked with small, black dots and the skin is rough. There are three longitudinal grooves on the head, and three large pores behind the eye. Adults average three and one-half inches in length.

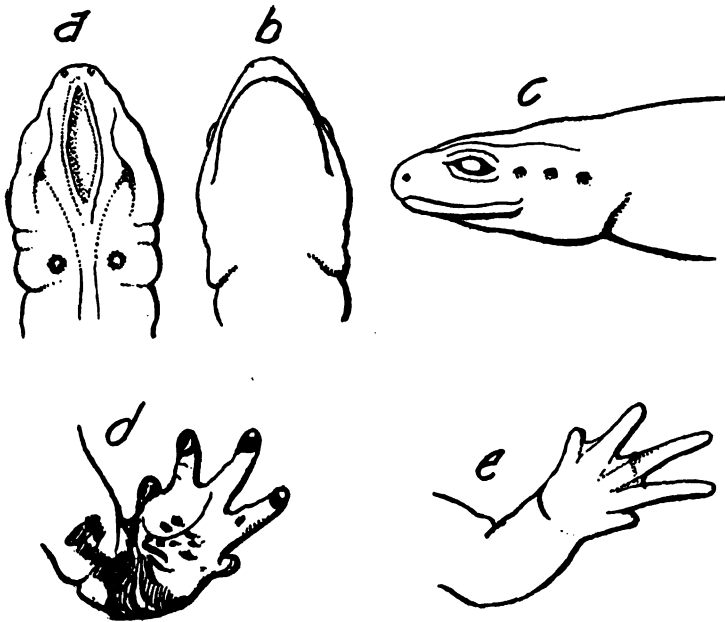


Fig. 14.—Structural characters of the Newt (*Diemictylus viridescens*): a, dorsal view of head; b, ventral view; c, lateral view; d, fore foot; e, ventral view of left hind foot of female. About twice natural size.

Original drawings from the Office of the State Zoologist.

It is very generally distributed throughout the eastern United States. Two hundred and thirty-three specimens were received from thirty-eight counties, by the Economic Zoologist. From the list below one can see that these counties represent practically all sections of this State:

Allegheny county,	Cruikshank, Dr. O. F.,	Swissvale.
Berks county,	Gruber, C. L.,	Kutztown.
Berks county,	Leibelsperger, I. H.,	Fleetwood.
Beaver county,	Mansfield, I. F.,	Beaver.
Blair county,	McGraw, H. A.,	Altoona.
Blair county,	Way, A. F.,	Altoona.
Bradford county,	Hoffman, J.,	New Albany.
Cambria county,	Seaman, L. I.,	Emporium.
Cambria county,	Baxter, Geo. A.,	Rising Spring.
Centre county,	Granbey, Mr.,	State College.
Centre county,	Tompson, J. H.,	Parkesburg.
Chester county,	Baldwin, O. F.,	Berwyn.
Chester county,	Clarke, J. A.,	Honey Brook.
Chester county,	Climenson, W. W.,	Coatesville.
Chester county,	Lawrence, J.,	Sabula.
Cleardfield county,	Brown, G. W.,	Meadville.
Crawford county,	Falvre, Jos.,	Moscow.
Crawford county,	Gilmore, L. B.,	Fort Hunter.
Dauphin county,	Anderson, C.,	Ingenook.
Dauphin county,	Eager, C.,	Harrisburg.
Dauphin county,	Good, E. Z.,	Williamstown.
Dauphin county,	Keloch, F. D.,	Ingenook.
Dauphin county,	Middleton, W.,	Fort Hunter.
Dauphin county,	Shatto, Clarence,	Williamstown.
Dauphin county,	Tooev, Eva,	Dauphin.
Dauphin county,	Zool. Office Attaches,	Rockville.
Dauphin county,	Zool. Office Attaches,	Waterford.
Erie county,	Gilbert, S. N.,	Mont Alto.
Franklin county,	Delong, C. A.,	McConnellsburg.
Fulton county,	Jackson, R. L.,	McConnellsburg.
Fulton county,	Johnson, J. K.,	Warfordsburg.
Fulton county,	Palmer, A. B.,	Huntingdon.
Huntingdon county,	Swope, J. P.,	Indiana.
Indiana county,	Wehrle, R. W.,	Reynoldsville.
Jefferson county,	Althouse, K. B.,	New Albany.
Jefferson county,	Hoffman, O. A.,	Littitz.
Jefferson county,	Miller, R. B.,	Olyphant.
Lancaster county,	Heiserman, J. J.,	Moscow.
Lackawanna county,	Carr, I. P.,	Pittston.
Lackawanna county,	Winship, L.,	Wilkes-Barre.
Luzerne county,	Campbell, C. W.,	Wilkes-Barre.
Luzerne county,	Hammeth, J. W.,	Williamsport.
Luzerne county,	Patterson, J. E.,	Williamsport.
Lycoming county,	Geddes, J. M.,	
Lycoming county,	Van Housen,	
Mifflin county,	McCartney, E. S.,	Tobychanna.
Monroe county,	Glogglar, B.,	Walnutport.
Northampton county,	Blinder,	Easton.
Northampton county,	Green, J. W.,	Nazareth.
Northampton county,	Knecht, F. R.,	Bangor.
Northampton county,	Oxford, T.,	Shamokin.
Northumberland county,	Snyder, E. W.,	Marshrunk.
Perry county,	Brightbill, H. A.,	Landisburg.
Perry county,	Stewart, Wm.,	Blain.
Perry county,	Waltman, C. A.,	Marysville.
Perry county,	Zool. Office Attaches,	Ulysses.
Potter county,	Carpenter, S. T.,	Mance.
Somerset county,	Bowman, D. H.,	Nordmont.
Sullivan county,	Welland, W. S.,	Maheshburg.
Tioga county,	Hulslander, H. P.,	Cherrytree.
Venango county,	Sims, Geo. B.,	Emulton.
Venango county,	Beau, L. S.,	Corydon.
Warren county,	Powers, B. J.,	Warren.
Warren county,	Simpson, R. B.,	Honesdale.
Wayne county,	Bullock, W. H.,	Stull.
Wyoming county,	Baker, B.,	Skinners Eddy.
Wyoming county,	Taylor, F. L.,	York New Salem.
York county,	Kopp, Chas.,	Jefferson, Ohio.
Ohio,	Sims, R. J.,	

During part of the time the Newt prefers an aquatic life, and is found under stones, leaves and other protective objects and among vegetation in the quiet water of ponds. When these dry up in summer, the Newts seek temporary shelter under stones, decayning plant substances and the like, there to await the fall rains, whose waters again fill the ponds.

A subspecies, named *miniatus* (Raf.), has been described as similar to the typical *Diemictylus viridescens*, except in color, which is vermilion in the subspecies. This is the terrestrial form of the same species, which lives on land during the second year of its life, and during this period assumes the red color. Its third year is the time for mating, for which it returns to the water, and resumes the green color.

The aquatic form is a good swimmer and often may be seen floating on the surface of the water. Ditmars points out that if the two forms be made to reverse their environment, they change in color accordingly; this fact indicates that the differences are due to environment. Thus, the bright vermilion *miniatus* becomes green, skin smooth, and tail keeled or finned; while the typical *viridescens* becomes vermilion and assumes a rough skin.

The eggs are laid singly in the water, are elliptical in shape, and attached to submerged vegetation by a sticky covering (Fowler). The young are provided with external branchiæ, which are retained until the animals are about one and one-half or two inches long.

Two hundred and thirty-three specimens were examined, and the stomachs of 121 were found to contain food. From the Table of Stomach Contents it is plain that snails form a large part of the food. Other important articles are flies and their larvæ, Coleoptera (beetles), snout beetles, Chalcid flies, ants, and vegetable matter. "Feeds on flies, and in fact any small insect dropped on the surface. Moves slowly towards its prey and suddenly snaps at it. If not successful they do not resume operations until another opportunity is offered. Their method is always slow and deliberate, and sometimes they seize and snap one another, apparently by mistake. If their prey is too large, they usually persist a long time till they are able to swallow. The red land form eats insects and worms" (Fowler). "Will seize bait and cling to it though not caught by the hook. Sometimes seeks places where flesh is regularly thrown into the water, as a place where fish are cleaned and the offal deposited" (Fowler). "Storer found fragments of *Lymnea*, *Physa*, insects, and spiders in their stomachs" (Smith).

ORDER III. SALIENTIA. THE TAILLESS AMPHIBIANS.

All the members of the Salientia are readily recognized by the short, broad body (which is devoid of a tail). All are fitted for leaping (Latin, *saliens*) in that the fore limbs are short, while the hind limbs are long and strong. The tongue is attached only in front. Frogs are distinguished structurally from toads by the fact that in the former the thoracic region (chest) cannot be expanded because of the attachment of certain bones in that region.

STRUCTURAL KEY TO THE FAMILIES OF SALIENTIA.

- A. Pupil of eye vertical (see Fig. 16); inner sole tubercle large, with extensive cutting edge (see Fig. 16).

VIII. *Pelobatidæ*. *The Spade-foot Toads*, page 115.

- B. Pupil of the eye not vertical; either horizontal or round.

- a. Parotid glands always present (see Fig. 15).

VII. *Bufo**nidæ*. *The Toads*, page 110.

- b. Parotid glands lacking (see Fig. 17).

- a'. Fingers and toes more or less enlarged at tips to form adhesive disks (see Figs. 17, 18, 19, 20).

IX. *Hylidæ*. *The Tree Frogs*, page 116.

- b'. Fingers and toes without disks. (See Figs. 21, 22, 23, 24, 25.)

X. *Ranidæ*. *The Frogs*, page 123.

FAMILY VII. BUFONIDÆ. THE TOADS.

The toads are characterized by the absence of teeth in the jaws. The toes are webbed, but not expanded at the tip. The parotids are prominent.

STRUCTURAL KEY TO THE PENNSYLVANIA SPECIES OF BUFONIDÆ.

- A. Olive brown above with brownish spots on the back. Under parts spotted. Bony crests on the head not grown together in front.

No. 19. *B. l. americanus*, page 110.

- B. Greenish or yellowish green above with blackish or brownish spots on the back. Under parts unspotted. Bony crests on the head grown together in front.

No. 20. *Bufo fowleri*, page 114.

No. 19. *Bufo lentiginosus americanus* (Le Conte). *The American Toad*.

Perhaps no amphibian is so well known to the average person as is the Toad, also known as the Common or Hop Toad. Despite its notoriety, few persons can give a definite description of its color. This varies considerably, but the typical shade is brownish olive, with brownish spots and with a yellowish line, which extends down the middle of the back. There are two black patches before the eyes and the tympanum, or ear, is large. Adults are very warty, while the young are nearly smooth. There is a bony ridge above and behind the eyes and the parotids are elliptical. Some examples are reddish, while immediately after molting the skin, green predominates. Adults reach a length of three and one-half inches.

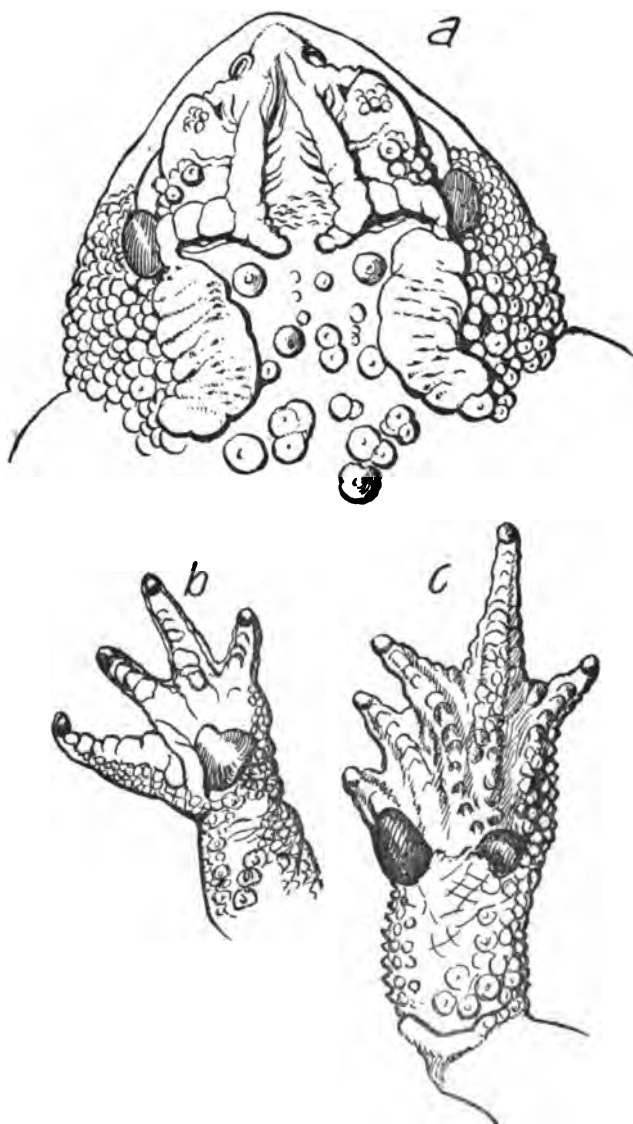


Fig. 15.—Structural characters of the American Toad (*Bufo lentiginosus americanus*): a, dorsal view of head; b, fore foot; c, hind foot. About 1 3-5 times natural size.

Original drawings from the Office of the State Zoologist.

The typical *Bufo lentiginosus* Shaw occurs in the eastern United States, while the form "*americanus* Le Conte" is restricted to the

northern States. While we made no special effort to collect toads, in the collection of the Division of Zoology are ninety-five specimens, from twenty-nine counties, as follows:

Allegheny county,	Cruikshank, Dr. O. F.,	Swissvale.
Beaver county,	Swager, J. E.,	Hookstown.
Bradford county,	Hoffman, J. L.,	New Albany.
Bucks county,	Winegartner, J.,	Doylstown.
Centre county,	Kuhn, T. C.,	State College.
Clarion county,	Blyson Camping Party,	Blyson.
Cumberland county,	Hipple, E. T.,	Mechanicsburg.
Dauphin county,	Coover, R.,	Harrisburg.
Dauphin county,	Fisher, W. S.,	Highspire.
Dauphin county,	Good, Mr.,	Harrisburg.
Dauphin county,	Martin, R.,	Harrisburg.
Dauphin county,	Zool. Office Attaches,	Dauphin.
Delaware county,	Lehman, S. M.,	Essington.
Erie county,	Selden, F. H.,	Cranesville.
Franklin county,	Delong, C. A.,	Mont Alto.
Fulton county,	Jackson, R. L.,	McConnellsburg.
Fulton county,	Palmer, A. C.,	Warfordsburg.
Fulton county,	Spade, G. F.,	Emmaville.
Huntingdon county,	Swope, J. P.,	Huntingdon.
Indiana county,	Wehrle, R. W.,	Blacklick.
Luzerne county,	Campbell, E. W.,	Wilkes-Barre.
Luzerne county,	Yorks, J. P.,	Wilkes-Barre.
Luzerne county, .....	.....	Pittston.
Lycoming county,	Rehn, D. N.,	Williamsport.
Mercer county,	Greenville High School,	Greenville.
Monroe county,	Allegar, I. L.,	North Water Gap.
Monroe county,	Gould, Mrs. E. V.,	Effort.
Montgomery county,	Adle, J. A.,	Norristown.
Northampton county,	Klausy, I. L.,	Portland.
Philadelphia county,	Miller, R. F.,	Frankford.
Schuylkill county,	Miller, A. B.,	Barnesville.
Tioga county,	Andrews, F. S.,	Wellsville.
Venango county,	Bean, J. S.,	Emulton.
Warren county,	Simpson, R. B.,	Warren.
Westmoreland county,	Fox, J. L.,	Mt. Pleasant.
Westmoreland county,	Shupe, W. A.,	Scottsdale.
Wayne county,	Bullock, Wm. H.,	Honesdale.
Wyoming county,	Mott, R. C.,	Meshoppen.
York county,	Crouse, B. C.,	York.
York county,	Eichelberger, L. E.,	York.

Toads are nocturnal in their habits and hide during the day in dark, damp, cool places, as under porches, boards, walks, and among rocks. After a rain they become very active, and as great numbers of earth worms are then driven from their homes by water in the soil they often form an important part of the toad's diet. That toads and worms come down with the rain is pure imagination, and today none but the superstitious persons believe such foolishness.

Toads are known to return to the same place of concealment day after day, and may remain in a certain locality for years. They are known also to reach a remarkable age; some authorities cite examples known to have been more than thirty years old (Dickerson, "The Frog Book," p. 73).

Toads protect themselves in a number of ways. Their common habit of playing dead saves them frequently. Then, too, the skin is provided with glands which secrete an offensive fluid that is so distasteful to dogs that they seldom attempt to bite a toad. Skunks are very fond of toads, which they commonly roll in the soil before eating (Dickerson, "The Frog Book," p. 17). This is believed to be done in order to remove the distasteful secretion from the skin glands. To man this secretion can cause no injury, except distaste in the mouth or irritation of the eyes, if transferred to them by the hands.

A common idea is that toads cause warts. Investigations have shown this idea is absolutely untrue, and no harm can come from handling these creatures. The toad is not deserving of the numerous reproachful statements that have been connected with its name, and that continue to exist purely through ignorance and superstition. Only when men cast these two detrimental traits aside will the toad occupy its deserving place in man's estimation.

About April the toads arouse and move to the ponds. When the toads retire to the water, the males begin to make their familiar trilling sound. This they do as they fill the throat with air and distend the sack until it is as large as the head. This singing is heard during the night, and may continue until mid-summer, but generally ceases when the males leave the water and go to the gardens and fields. At this season the males also develop special great pads on the inside of their thumbs, which help them retain their places in mating.

The eggs are deposited in the familiar long strings. These are made up of a gelatinous substance, in which the eggs are distributed at quite regular intervals. The eggs are black and very small. A single toad may deposit upwards of 4,000. The mass swells rapidly and if the temperature of the water be favorable the tadpoles appear in a few days. They grow so rapidly that in about a month or two the young toads leave the water. Many snakes, and such birds as herons, bitterns, crows, owls, hawks, shrikes and chickens, find them very palatable and seek them eagerly. They are also readily devoured by most serpents. Toads reach maturity in from two to four years. Not until mature do they resort to the ponds to breed.

The toad comes forth after sunset in search of food. Its tongue is fastened in front, but free behind, and, being provided with a sticky secretion, is well fitted in securing the food to touch it and instantly bring it into the capacious mouth. In this it confines its efforts to small moving creatures. Upon these it moves stealthily and by a quick thrust of the tongue the prey is secured. Large earthworms are swallowed by degrees. The young toads confine their efforts to suitably small creatures, of which ants are no small item. The toad is a most beneficial animal, and is to be placed in the front ranks of the true friends of the farmer. It devours an astonishing and great variety of insects. As a beneficial creature its place cannot be questioned, and this is especially so in gardens, where it does its full duty and should be encouraged to remain. As will be seen from the Table of Stomach Contents, among insect food, the ants, ground beetles, click beetles, and snout beetles (or weevils) are important. Cutworms, thousand-legged "worms" and sow-bugs form no small part. Upwards of 3,000 insects or their larvæ may be destroyed by a toad in the course of a month. "Toads are among the most beneficial

animals to man on account of the large number of insects which they destroy" (Fowler). "The toad eats almost all kinds of small living things that are out in the late afternoon and at night" (Dickerson). "The toad ranks first in the list of useful species. At twilight multitudes of toads issue forth to prey upon all forms of insect life, continuing the hunt throughout the night, and retiring at dawn for digestion" (Ditmars).

Exhaustive studies of the food of the toad were not made in this office because this subject has been studied so extensively, and given such wide publicity by others, especially Prof. Hodge, of Massachusetts, that it appears unnecessary to sacrifice the life of such beneficial creatures for the sake of investigations that only duplicate results already obtained. However, those persons who wish to study the food of frogs and toads, without killing the animals, should know that this can be done by forcing open the mouth and scooping out the stomach contents with a looped wire.

No. 20. *Bufo fowleri* (Putnam). **Fowler's Toad.**

Fowler's Toad varies considerably in its ground color which may be gray or brown with a greenish or yellowish hue: some specimens are reddish. Greenish gray or yellowish gray predominates, however. The dorsal spots, which are usually brown or black, are arranged in a well defined pattern. These spots generally cover the larger warts of the back. The skin of the back is everywhere warty but the warts are rather fine and small compared with those of the Common Toad. The under parts are light and unspotted but have a granulated appearance. The throat of the male is black, while that of the female is light, sometimes spotted on the jaws. Fowler's Toad is medium in size; the males average $2\frac{1}{2}$ inches in length, while the females are slightly larger. The parotids are long, narrow, and oval. The bony crests on the head are quite conspicuous, being elevated considerably and they are parallel and grown together in front (a distinction from the Common Toad).

This toad has been recorded from the New England States and the vicinity of New York. Dr. Leonhard Stejneger has kindly furnished the following Pennsylvania records from the collection in the Smithsonian Institution, United States National Museum, Washington, D. C.:

Philadelphia,	Philadelphia county, ..	J. H. Richard.
Philadelphia,	Philadelphia county, ..	J. H. Richard.
Erie,	Erie county,	Cloud Rutter.

Fowler's Toad appears several weeks later in the spring than does the Common Toad. It deposits its somewhat smaller eggs in strings as does the latter species, but these are often in two rows.

It is a slender built toad and is accordingly a more active creature than its cousin. It is nocturnal and is very agile in its movements, being found in fields and gardens and along roadsides, where it is in search of insect food.

FAMILY VIII. PELOBATIDÆ. THE BURROWING TOADS.

The burrowing toads, unlike the common toads, possess teeth in the upper jaw. The heel is provided with a spur which is used in digging.

No. 21. *Scaphiopus holbrooki* (Harlan). The Spade-foot Toad.

This animal is known by a number of names, such as Spade-foot, Hermit Toad, Hermit Spade-foot, and Hermit Spade-foot Toad. Above it is brown, which in some specimens is yellowish, and in others greenish. Some examples show a broad yellow line on each side. The under

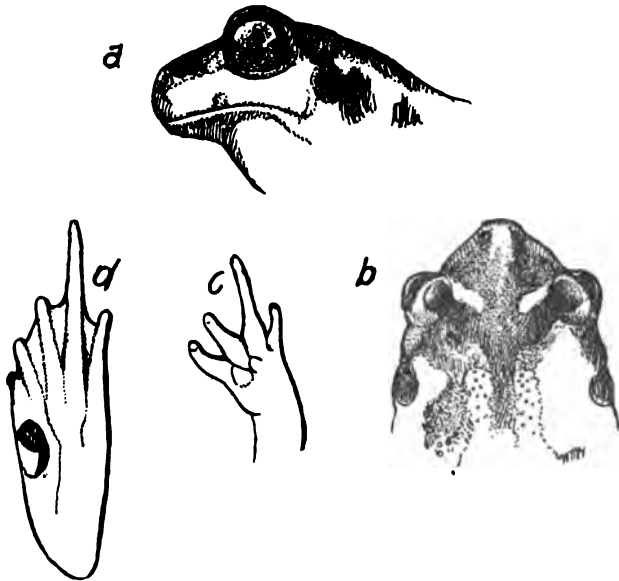


Fig. 16.—Structural characters of the Spade-foot Toad (*Scaphiopus holbrooki*): a, lateral view of head, showing vertical pupil; b, dorsal view; c, fore foot; d, hind foot. About 1 1-3 times natural size.

Original drawings from the Office of the State Zoologist.

parts are soiled white. Adults average three inches in length. As the Common Toad is the only other species with which the Spade-foot may be confused, a simple means of separating the two species is based on the fact that the pupil of the eye of the Common Toad is horizontal, while in the Spade-foot it is vertical.

This toad is distributed over the entire Eastern United States. It is not at all commonly observed, a fact which may be accounted for by its retiring and burrowing habits. Our collection contains but one specimen, sent alive by Mr. I. L. Allegar, of Shawnee, Monroe County.

The Spade-foot Toad spends the majority of its life in its burrows, which may be several feet long, or quite shallow and turnip-shape. Some animals may remain in the burrows for weeks, or may leave the burrow and sally forth at night, as they are strictly nocturnal in their habits. Indeed, about the only time they give up their burrowing habit for any extended period is during the breeding season, when in spring they go to the ponds. The eggs, like those of the Common Toad, are deposited in strings. The female utters a low sound, while the voice of the male is, comparatively speaking, exceedingly loud, and the sound is re-enforced by the distended throat sac. Generally the adults do not remain in the water longer than a few days, and then disappear entirely. The tadpole stage is of short duration. The young on leaving the water soon assume the burrowing habit of the parents.

The food of the Spade-foot Toad is stated as being "insects" (Holbrook), but practically nothing appears in literature on the subject. The stomach of the single specimen which was examined in the laboratory of the Economic Zoologist contained a Carabid or Ground Beetle.

FAMILY IX. HYLIDÆ. THE TREE FROGS.

In the members of the *Hylidæ* both the upper jaw and vomer are provided with teeth. The fingers and toes are more or less dilated into disks at the tip. These disks aid the frogs in clinging to the surfaces over which they move.

STRUCTURAL KEY TO THE SPECIES OF HYLIDÆ.

- A. Disks on toes and fingers of medium or large size.
 - a. Skin smooth or nearly so. No. 24. *Hyla pickeringii*, page 121.
 - b. Skin rough with small warts. No. 20. *Hyla versicolor*, page 119.
- B. Disks on fingers and toes so small as to be scarcely discernible.
 - a. Skin rough; webs very large; muzzle long and pointed; legs long; size one inch or less. No. 21. *Acris gryllus crepitans*, page 117.
 - b. Skin smooth; webs minute or lacking; muzzle rounded in profile; slightly projecting beyond line of jaw; size one inch or slightly more. No. 22. *Chorophilus nigratus feriarum*, page 118.

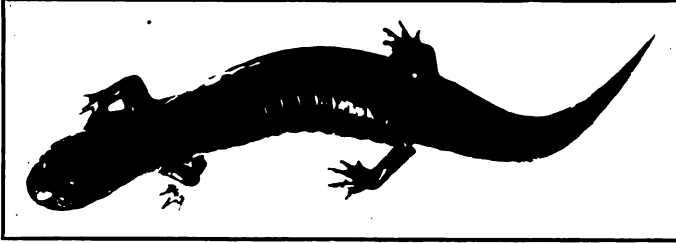


Plate VII, Fig. 1.—Dorsal view of the Red Salamander (*Spelerpes ruber*), showing the costal grooves. About three-fourths natural size. Photographed in the office of H. A. Surface, Economic Zoologist.

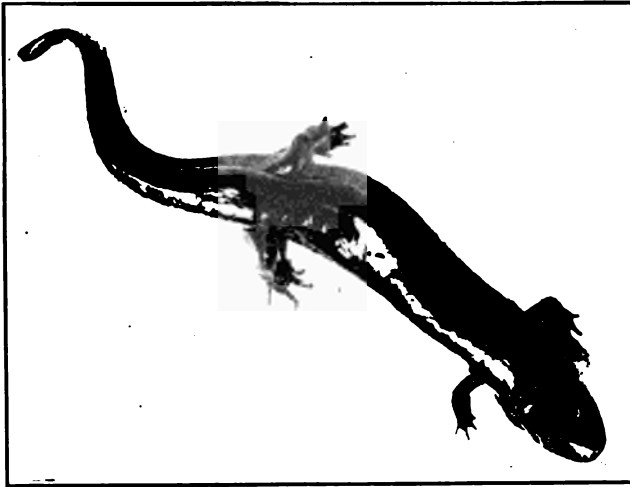


Plate VII, Fig. 2.—Dorsal view of the Dusky Salamander (*Desmognathus fusca*). About natural size. Photographed in the office of H. A. Surface, Economic Zoologist.



Plate VIII, Fig. 1.—Dorso-lateral view of the American Toad (*Bufo lentiginosus americanus*). About three-fourths natural size. Photographed in the office of H. A. Surface, Economic Zoologist.



Plate VIII, Fig. 2.—Dorso-lateral view of a Tree Frog, showing the disks on the toes. About one and one-fourth times natural size. Photographed in the office of H. A. Surface, Economic Zoologist.

DISCUSSION OF THE HYLIDÆ BY SPECIES.

No. 22. *Acris gryllus crepitans* (Baird). The Cricket Frog.

The Cricket Frog is also known as the Savanna Cricket, Peeper, Savanna Cricket Frog, and Rattler. It ranges from five-eighths of an inch to an inch or a little more in length. Usually the predominating color is brown above. A white line extends from the eye to the arm, and there are three oblique blotches on the sides. Three transverse bands are on the legs or these bands may give way to blotches. The under parts are light colored. In spring the throat of the male is yellowish.

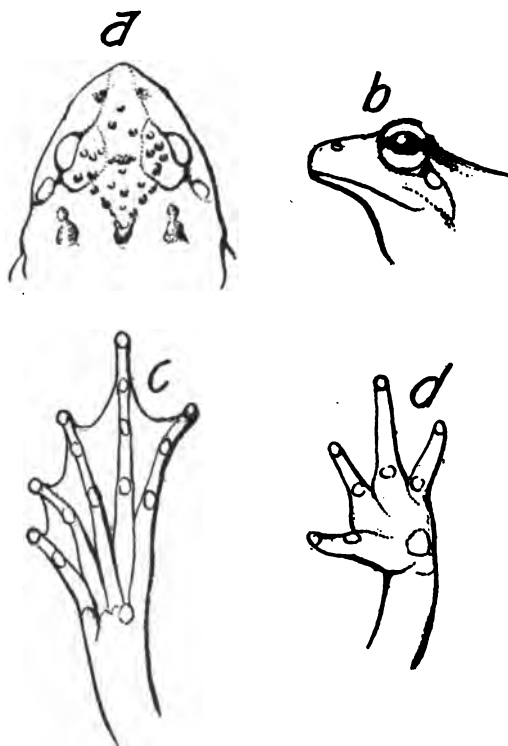


Fig. 17.—Structural characters of the Cricket Frog (*Acris gryllus crepitans*): a, dorsal view of head; b, lateral view; c, hind foot; d, fore foot. About three times natural size.

Original Drawings, from the Office of the State Zoologist.

It is found practically throughout the Eastern United States and is confined to swampy situations, large and small, or to the margins

of streams. Our collection includes eighty-two specimens, from six counties, as follows:

Adams county,	MacMillan, D. K.,	Gettysburg.
Allegheny county,	Atkinson, Dr.,	Westview.
Cumberland county,	Zool. Office,	Enola.
Dauphin county,	Zool. Office,	Higaspire.
Dauphin county,	Zool. Office,	Dauphin.
Dauphin county,	Zool. Office,	Harrisburg.
Montgomery county,	Brunner, M. M.,	Iron Bridge.
York county,	Zool. Office,	Peach Bottom.

The Cricket Frog is very shy and is difficult to approach. It lives in the rank vegetation and, when alarmed, takes to the water, in which it can swim readily but seldom dives. It is the most common "meadow peeper." When approached it ceases "peeping" and, because of this fact together with its retiring nature, search for it is not often rewarded. It is, however, easily seen and taken by the aid of a lantern at night.

The breeding season occurs in April or early in May. The eggs are deposited in small clusters attached to stems or leaves of aquatic plants. The song resembles the rattling of pebbles, slow at first, but increasing gradually in a succession of some thirty beats. At this time the throat is swollen until it is practically spherical and about one-half inch in diameter. During the breeding season the singing occurs in chorus during the day and evening. At other times the Cricket Frog is diurnal; then individuals may be heard. Tadpoles may be found as late as August.

Unlike most frogs, this species does not wait for its prey, but secures its food by successive leaps until it approaches and catches its victim, which may have been seen some distance away. Of eighty-two stomachs examined, fifty-eight contained food. Chief among this were found spiders, leaf hoppers, plant lice, flies, beetles, ants and other Hymenoptera. "It catches its insect food by giving prodigious leaps, after the insect has been sighted at a distance,"—(Dickerson). "It feeds on various kinds of insects."—(Holbrook).

No. 23. *Chorophilus nigritus feriarum* (Baird). The Swamp Tree Frog.

The Swamp Tree Frog is of a bluish gray color, with a dark stripe extending from the snout along the back. This stripe divides about half way back and forms a letter "V." On each side of this and on each side of the head and body is another stripe. Adults average one inch in length, but in this and the color there is some variation. Below, the animal is yellowish white, but the throat of males is greenish,

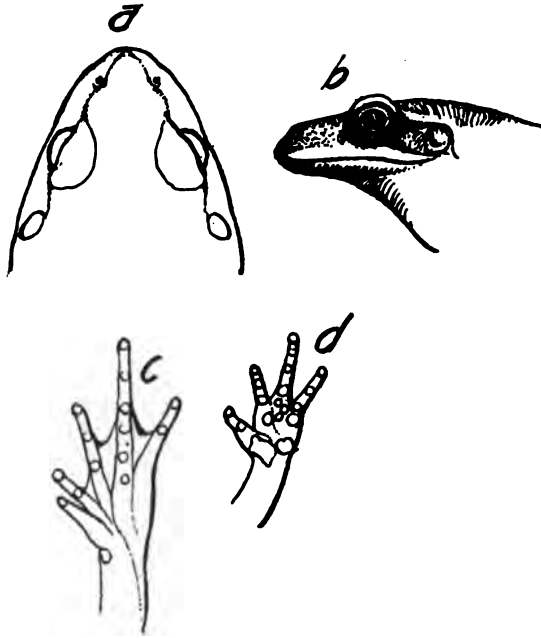


Fig. 18.—Structural characters of the Swamp Tree Frog (*Chorophilus nigratus feriarum*): a, dorsal view of head; b, lateral view; c, hind foot; d, fore foot. About three times natural size.

Original Drawings, from the Office of the State Zoologist.

This frog is found in practically all parts of the United States. Our collection includes but two specimens from the following:

Allegheny county,	Atkinson, Dr. D. A.,	Westview.
Cumberland county,	Office Attaches,	Enola.

It is fond of swampy ground especially where temporary pools occur. In March and April the eggs are deposited in small clusters attached to vegetation in the water. The tadpoles are very dark in color. The call of adult males resembles a rattle, the sound being soft, and rising toward the end. Though not loud, the singing of individuals stands out distinctly.

Neither of the specimens examined showed any stomach contents. "They feed upon flies, beetles and various insects that frequent marshy places."—(Dickerson).

No. 24. *Hyla versicolor* Le Conte. The Common Tree Frog.

The Common Tree Frog is known also as the Tree Frog and Tree Toad. It averages two inches in length; has a short, broad head, and a stout body. The color varies through shades of gray, brown

and green. There is an oblique, dark band on the top of the head above each eye. A large patch on the back is irregular in outline. The skin is rather warty. Below, the body is whitish, changing to orange yellow posteriorly. The ear is about two-thirds the size of the eye. Changes in color of the body take place slowly (generally about one-half hour is required) and in accordance with the color of the object on which the frog is resting.

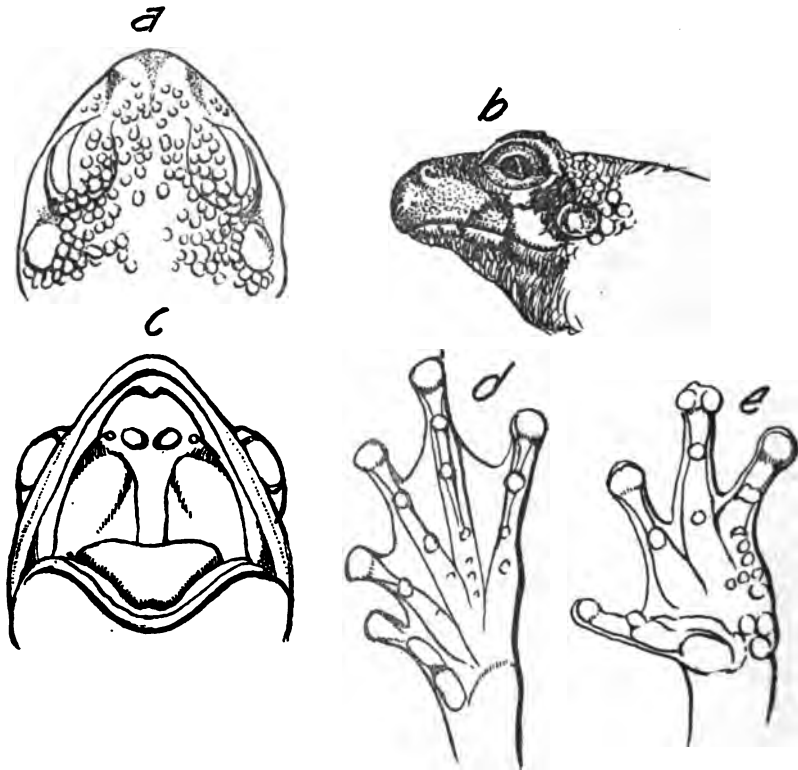


Fig. 19.—Structural characters of the Common Tree Frog (*Hyla versicolor*): a, dorsal view of head; b, lateral view; c, ventral view, mouth open; d, hind foot; e, fore foot. About twice natural size.

Original drawings from the Office of the State Zoologist.

This Tree Frog occurs throughout Eastern North America, and is generally regarded as second only to the Common Toad in abundance. Its protective coloration, however, serves to conceal it, so that despite its wide distribution it is not very generally known. Thus from the sixty-seven counties of Pennsylvania we received specimens from but sixteen, as follows:

Allegheny county,	Krantwurm, G.,	Pittsburgh, ..
Berks county,	Leibelsperger, I.,	Fleetwood, ..
Chester county,	Climenson, W. W.,	Honey Brook, ..
Dauphin county,	Fisher, W. S.,	Highspire, ..
Dauphin county,	Keboch, F. D.,	Williamstown, ..

Dauphin county,	Parnell, R. and G.,	Williamstown.
Dauphin county,	Shuey, J. A.,	Penbrook.
Franklin county,	Finrock, J. L.,	Mercersburg.
Franklin county,	Marden, G. A.,	Mont Alto.
Fulton county,	Palmer, A. C.,	Warfordsburg.
Lehigh county,	Poster, C. C. E.,	Jacksonville.
Lycoming county,	Fassold, C.,	Hughesville.
Lycoming county,	Gorham, W. R.,	Hartley Hall.
Montgomery county,	Sever, E. M.,	Hatfield.
Northumberland county,	Redline, W. W.,	Northumberland.
Northampton county,	Krotzwarum, G. J.,	Easton.
Northampton county,	Wimmer, G. J.,	Nazareth.
Susquehanna county,	Main, C. A.,	South Montrose.
Tioga county,	Hughes, Mrs. A. F.,	Tioga.
Venango county,	McGinnis, H. B.,	Eminton.
Washington county,	Couch, Merle,	Canonsburg.
Warren county,	Simpson, R. B.,	Warren.
New York,	Puckard, W.,	Pen Yan, N. Y.

This species is provided with well developed disks on the toes,—a development that fits this frog well for its life on trees and bushes. Indeed, it is an expert acrobat, and jumps, with apparent unconcern for its safety, from branch to branch as it pursues its insect food. The Tree Frog frequents orchard and forest trees, fences, hedges and shrubbery. After April, in the evenings and especially in damp weather, its clear, trilled rattle is heard. This is supposed to be a forecast of wet weather, but Mr. Palmer suggests that it is probably only a sign of contentment.

The light-colored eggs are deposited in shallow, reedy pools in small clusters or singly, and attached to grasses or stems in the water. Generally the eggs hatch in about three days. The tadpoles, yellow at first, grow rapidly and in three weeks the hind legs begin to make their appearance.

The food is secured as the Tree Frog moves about over the trees. Insects, seen several feet away, are quickly captured by a leap to their location and by a quick thrust of the frog's sticky tongue. This Tree Frog is most active at dusk and at night. The food consists of such insects as are found on trees and shrubbery,—beetles, long-horned grass-hoppers, and ants. "In fine weather it climbs the highest trees for insects"—(Smith). "Feeds on Insects"—(Holbrook). "In captivity, will take flies and bugs"—(Palmer). The Table of Stomach Contents shows spiders, long-horned grass-hoppers, tree-cricket (Ecanthus), shield-bugs (Pentatomidæ), leaf hoppers (Jassidæ), moths and butterflies (Lepidoptera and their larvæ—caterpillars), beetles (Coleoptera) and their larvæ, click beetles (Elateridæ), and ants.

No. 25. *Hyla pickeringii* Holbrook. The Spring Peeper.

The Spring Peeper, also called the Peeper, Peep, Pickering's Frog, and Pickering's Tree Toad, is of a fawn to brown color. There is a V-shaped bar between the eyes and an oblique cross on the back. The legs are barred. The under parts are of a light color. The throat of the male is brown. Adults average an inch in length.

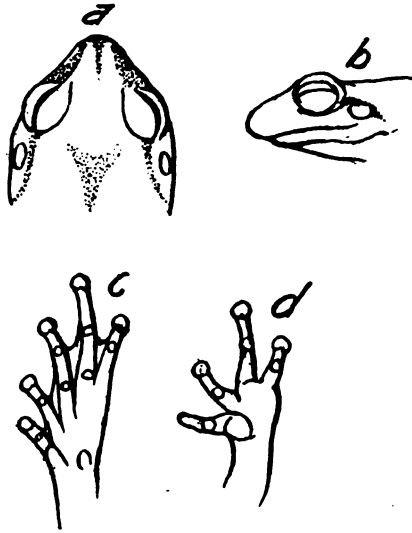


Fig. 20.—Structural characters of the Spring Peeper (*Hyla pickeringii*): a, dorsal view of head; b, lateral view; c, hind foot; d, fore foot. About three times natural size.

Original Drawings, from the Office of the State Zoologist.

This species is found in most of the Eastern United States where it is quite abundant but is more often heard than seen. Our collection includes specimens from seven counties, as follows:

Allegheny county,	Atkinson, Dr. D. A.,	Westview.
Allegheny county,	Krautwurm, G.,	Pittsburgh.
Chester county,	Brittian, W.,	Downingtown.
Chester county,	Jackson, T. H.,	West Chester.
Dauphin county,	Zool. Office Force,	Harrisburg.
Dauphin county,	Ulrich, D. C.,	Penbrook.
Dauphin county,	Zool. Office Force,	Rockville.
Dauphin county,	Zool. Office Force,	Middletown.
Indiana county,	Wehrle, R. W.,	Indiana.
Montour county,	West, Mrs. G. P.,	Danville.
Perry county,	Office Attaches,	Marysville.
Wayne county,	Bullock, W. H.,	Honesdale.

Until the approach of the fall, the Spring Peeper lives in marshy land, overgrown with grasses. When alarmed it hides among the vegetation and for this reason it is hard to capture. Consequently, the Peeper is not so common in collections. Not only does the Peeper hide but it also remains silent. If the listener be patient, however, the frightened frogs gradually break the silence, and more distant ones begin to call, then those nearer and nearer, until near individuals have joined the chorus. When fall comes these frogs desert the water and then may be found in trees.

The eggs are generally deposited in April, singly, on plants in the water, or they may be found free on the bottom of a pool. The eggs are brown above and gray below. Only a short period elapses until they hatch, and the tadpole stage is likewise of short duration.

Of fifty stomachs examined, seventeen contained food. Prominent among the articles of diet were spiders, weevils and ants. "Their main interest in life lies in hunting small insects"—(Dickerson). "It feeds on small insects, as flies, etc."—(Holbrook).

FAMILY X. RANIDÆ. THE TRUE FROGS.

The true frogs are members of the family Ranidæ, and have well-developed teeth on the upper jaw and vomer. The ear is well developed, and in our species the hind toes are full-webbed and without disks.

STRUCTURAL KEY TO THE SPECIES OF RANIDÆ.

A. Lateral folds present.

a. Skin with longitudinal folds between the lateral folds; definitely outlined spots on the back and sides.

a'. Spots rather square; under surface of legs bright orange-yellow.

No. 26. *Rana palustris*, page 125.

b'. Spots rounded, outlined with lighter shade.

No. 25. *Rana pipiens*, page 123.

b. Skin relatively smooth between the lateral folds.

a'. Ear of male larger than eye; legs short; no black cheek patch; no definite pattern of spots; size $3\frac{1}{2}$ to 4 inches; throat of male yellow.

No. 28. *Rana clamitans*, page 129.

b'. Ear of male not larger than eye; legs long; brown or gray.

No. 27. *Rana sylvatica*, page 127.

B. Lateral folds absent; ear of male larger than eye; legs relatively short; webs large; head broad; size very large—7 to 8 inches.

No. 29. *Rana catesbeana*, page 131.

DISCUSSION OF THE RANIDÆ BY SPECIES.

No. 26. *Rana pipiens* Schreber. The Leopard Frog.

The Leopard Frog is also known as the Common Shad Frog, Spring Frog and Field Frog. This species is called the Leopard Frog because of its spotted coloration. The ground color varies from bright green to gray or brown. This is marked with irregular, dark brown or black blotches, which are edged with whitish, and which form two

irregular rows on the back. There are generally two spots between the eyes, and the legs are barred above. The under parts are pale in color. Adults may be three inches or more in length.

This species is found throughout the United States, east of the Sierra Nevada, and is a very common form. It occurs in both brackish and fresh water swamps and prefers swampy meadows to large bodies of water. It is a very active species and an excellent leaper, being able to jump eight feet or more at a time. When disturbed it may sink below the surface of the water, but prefers to hide in the tall grass, where it is well hidden by the protective coloration. Nine counties of Pennsylvania are represented in our collection of sixty-nine specimens:

Allegheny county,	Brumbaugh, C. L.,	Wilkinsburg.
Bradford county,	Clubbuck, C.,	Rome.
Dauphin county,	Barrington, H.,	Paxtang.
Dauphin county,	Carruthers, D.,	Harrisburg.
Dauphin county,	Zool. Office Attaches,	Dauphin.
Dauphin county,	Zool. Office Attaches,	Middletown.
Dauphin county,	Zool. Office Attaches,	Highspire.
Indiana county,	Wehrle, R. W.,	Indiana.
Luzerne county,	Angus, Wm.,	Pittston.
Lebanon county,	Ross, G. R.,	Lebanon.
Venango county,	Bean, L. S.,	Eminton.
Washington county,	Couch, Joseph,	Canonsburg.
Washington county,	Couch, Merle,	Hickory.
Westmoreland county,	Berg, E. F.,	Mt. Pleasant.

The note is a rasping call produced by distending the oval pouches under the arms. The Leopard Frog is particularly noisy about the middle of April. The eggs are laid in March and April in large masses, which sometimes contain upwards of 6,000 eggs. These clusters are attached to vegetation or, less frequently, may be floating. The eggs are dark in color and hatch in about ten days. It is not for several days that the tadpoles begin to feed actively, but cling, instead, to vegetation by means of suckers which secrete a sticky substance. All become active feeders within four to seven days, and by July or August the tail is absorbed, the small frogs lose their gills and become breathers and inhabitants of the air.



Plate IX.—Dorsal view of the Leopard Frog (*Rana pipiens*). Slightly more than three-fourths natural size. Photographed in the office of H. A. Surface, Economic Zoologist.



Plate X.—Dorsal view of the Pickerel Frog (*Rana palustris*). About one-half natural size. Photographed in the office of H. A. Surface, Economic Zoologist.



Plate XI.—Dorso-lateral view of the Green Frog (*Rana clamitans*). About three-fourths natural size. Photographed in the office of H. A. Surface, Economic Zoologist.

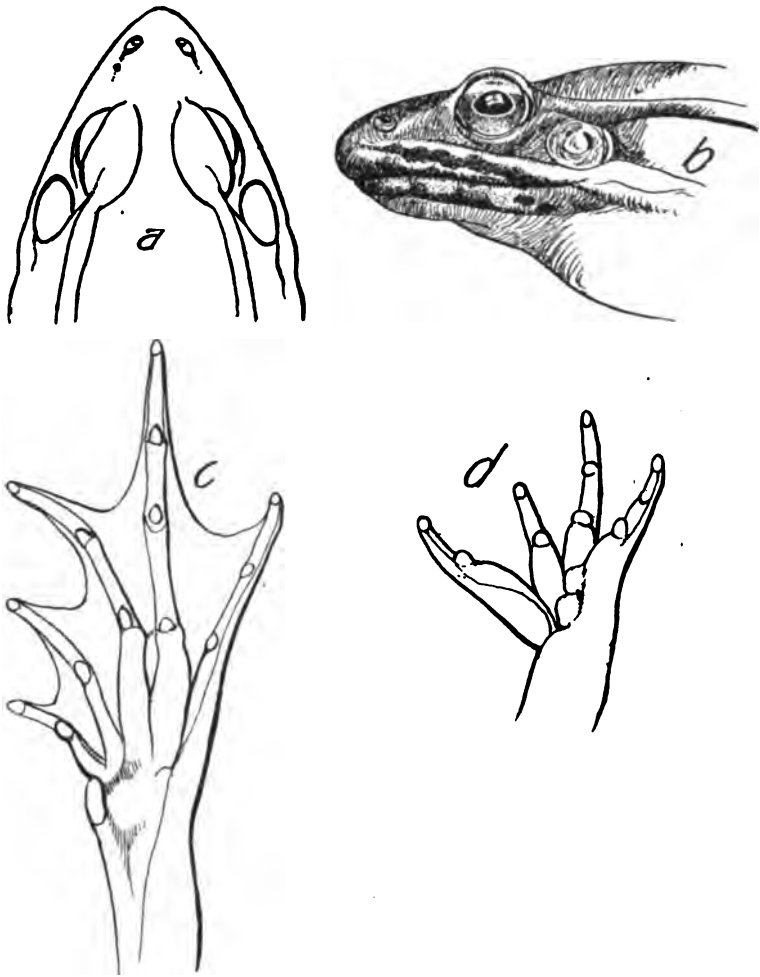


Fig. 21.—Structural characters of the Leopard Frog (*Rana pipiens*): a, dorsal view of head; b, lateral view; c, hind foot; d, fore foot. About twice natural size. Original drawings from the Office of the State Zoologist.

The food of adults consists of spiders, grasshoppers, crickets, ground beetles, leaf hoppers and numerous species of beetles. (See the Table of Stomach Contents.) "Eats worms and insects of all kinds"—(Dickerson). "It feeds on insects"—(Holbrook).

No. 27. *Rana palustris*. Le Conte. The Pickerel Frog.

This species is known by a great many common names such as Poison Frog, Poison Bully, Zebra, Tiger, Marsh, Grass, and Yellow-leg Frog. The name "pickerel" is applied because this frog is fre-

quently used as bait in fishing for pickerel. The ground color of the back is light brown, with two rows of large, oblong blotches of dark brown. Sometimes there are four rows; that is, one row

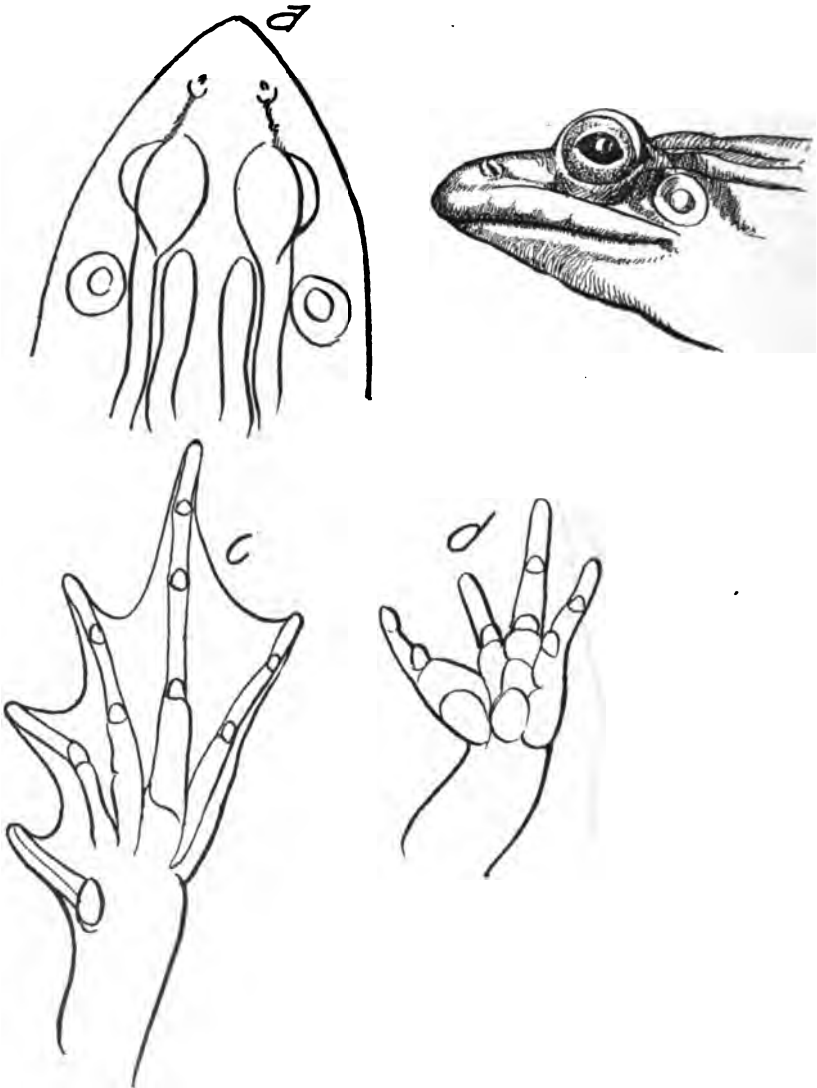


Fig. 22.—Structural characters of the Pickerel Frog (*Rana palustris*): a, dorsal view of head; b, lateral view; c, hind foot; d, fore foot. About $1\frac{1}{2}$ times natural size.

Original drawings from the Office of the State Zoologist.

below each fold. There is a dark spot above the eye and a dark line from the nostril to the eye. The upper jaw is white, spotted with

black. The head is short and blunt, and the toes are well webbed. The ear is smaller than the eye. The average length is about two and three-quarter inches.

The Pickerel Frog is found throughout the Eastern United States. In our collection are one hundred and nine specimens, from seventeen counties, as follows:

Adams county,	Zool. Office,	Gettysburg.
Allegheny county,	Brumbaugh, C. L.,	Wilkinsburg.
Berks county,	Boyetown High School,	Boyetown.
Berks county,	Gruber, C. L.,	Kutztown.
Bradford county,	Hoffman, J. L.,	New Albany.
Cumberland county,	Zool. Office Attaches,	Enola.
Dauphin county,	Henschen, Prof.,	Harrisburg.
Dauphin county,	Zool. Office Attaches,	Dauphin.
Fulton county,	Jackson, R. L.,	McConnellsburg.
Huntingdon county,	Swope, J. K.,	Huntingdon.
Indiana county,	Wehrle, R. W.,	Indiana.
Montgomery county,	Brunner, Wm. N.,	Collegeville.
Montour county,	West, H. K.,	Danville.
Northampton county,	Kinney, I. L.,	Portland.
Northumberland county,	Pelfer, F. W.,	Fishers Ferry.
Warren county,	Hartzel, E. B.,	Warren.
Wayne county,	Bullock, W. H.,	Honesdale.
Westmoreland county,	Myers, R. I.,	Wetty.
York county,	Zool. Office,	Peach Bottom.

The specific name "*palustris*" signifies "a marsh" or "swamp." These frogs, however, live in damp, grassy meadows and fields, and along brooks, but frequently wander to grassy situations some distance from water. In fact, they are more apt to be found away from water than in it. The voice of the male is a low, prolonged, grunting sound, the pitch of which varies with individuals.

The eggs are deposited in May in shallow water. They are brown above and pale colored beneath. The transformed tadpoles leave the water in August or September and live along the grass-grown shores of streams and ponds.

Of 109 stomachs examined, 88 contained food. This was found to consist mainly of earthworms, spiders, thousand-legged "worms," grasshoppers, crickets, leaf-hoppers, Lepidopterous larvæ, various species of beetles and ants. "It is likely that Pickerel Frogs find acceptable any insect that makes its home about the brook or that comes there to deposit its eggs in the water or to get honey from the flowers that grow there"—(Dickerson).

No. 28. *Rana sylvatica*. Le Conte. The Wood Frog.

The Wood Frog varies in color from fawn to reddish brown, with arms and legs barred above. The head is small and pointed. A light line extends along the jaw from the snout to the shoulder. The underparts are yellowish or whitish. Males average two inches and females, three inches in length.

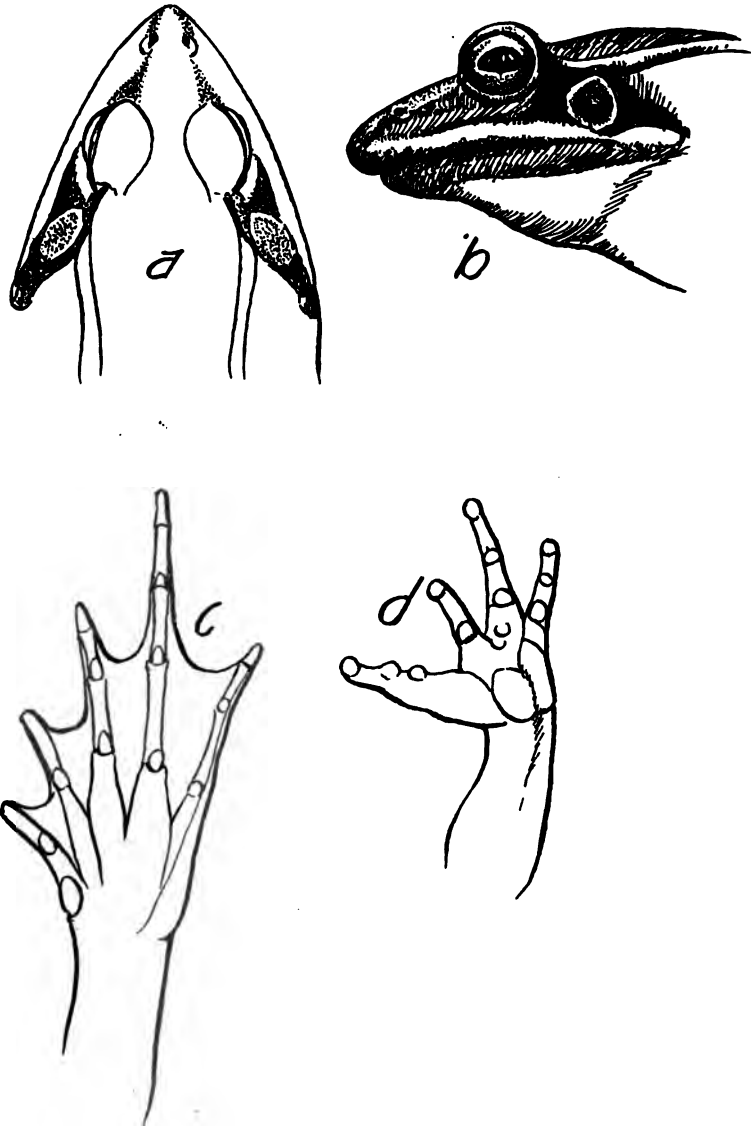


Fig. 23.—Structural characters of the Wood Frog (*Rana sylvatica*): a, dorsal view of head; b, lateral view; c, hind foot; d, fore foot. Slightly less than twice natural size.

Original drawings from the Office of the State Zoologist.

The typical *Rana sylvatica* Le Conte is confined to the North-eastern United States. It is a good swimmer, but is less frequently found about water than any other of our frogs. It prefers woodland where there are cool, shady and damp conditions, and where its obscure colors harmonize so well with the dead leaves and other

brown or gray substances on the ground. In our collection are 32 specimens from 12 counties:

Allegheny county,	Atkinson, Dr. D. A.,	Westview.
Allegheny county,	Brumbaugh, C. L.,	Wilkinsburg.
Allegheny county,	Cruikshank, Dr. O. F.,	Swissvale.
Berks county,	Becker, W. D.,	Fleetwood.
Bucks county,	Cox, E. G.,	Buckingham.
Cambria county,	Seaman, G. W.,	Wilmore.
Cambria county,	Settemyer, C. T.,	Wilmore.
Dauphin county,	Zool. Office,	Rockville.
Dauphin county,	Sober, Miss,	Dauphin.
Dauphin county,	Ulrich, D. C.,	Penbrook.
Erie county,	Selden, F. H.,	Cranesville.
Franklin county,	Delong, C. A.,	Mont Alto.
Luzerne county,	Campbell, E. W.,	Wilkes-Barre.
Perry county,	Brightbill, H. A.,	Marsh Run.
Potter county,	Carpenter, I. S.,	Ulysses.
Warren county,	Simpson, E. E.,	Warren.
Wayne county,	Bullock, W. H.,	Honesdale.

This species deposits its eggs in March or April in clusters, which are generally attached to twigs or grasses in shallow water. If the season be warm, the eggs hatch in about ten days. When the young frogs leave the water they are about one-half inch long, bronze color beneath, and black above. It is only during the breeding season that one hears the hoarse-croaking of the Wood Frog, and at other times it is an unusually silent species. In this respect the Wood Frog is much like the Toad.

"It is much more alert in getting food (than the other frogs), resembling the toad in this respect. It sees the moving insect at a distance of several feet, stealthily walks or creeps toward it, and perhaps follows it some distance, before making the capture"—(Dickerson). Of 32 stomachs examined, 28 contained food, which consisted largely of thousand-legged "worms," flies and beetles.

No. 29. *Rana clamitans* Latreille. The Green Frog.

The Green Frog is also known as the Spring Frog, Bully, Yellow-throated Green Frog, and Pond Frog. It is brilliant green in front and brownish olive posteriorly, often marked with irregularly small, dark spots. The under parts are whitish, changing to yellow on the throat of the male, and spotted with drak blotches in the female. In females the tympanum is about the size of the eye, but it is one and one-half times as large in males. The toes are well webbed. The males average about three inches in length and females, four inches.

This species is very common throughout the Eastern United States. Our collection includes 128 specimens, from 23 counties of Pennsylvania:

Adams county,	Zool. Office,	Gettysburg.
Allegheny county,	Cruikshank, Dr. O. F.,	Swissvale.
Berks county,	Gruber, C. L.,	Kutztown.
Bradford county,	Hoffman, J. L.,	New Albany.
Cambria county,	Seaman, G. W.,	Wilmore.
Cumberland county,	Shick, Harris,	Camp Hill.
Dauphin county,	Harrington, H.,	Parang.
Dauphin county,	Garman, P.,	Harrisburg.
Dauphin county,	Keboch, F. D.,	Williamstown.

Dauphin county,	Parnell, R. and G.,	Williamstown.
Dauphin county,	Office Attaches,	Dauphin.
Dauphin county,	Office Attaches,	Rockville.
Dauphin county,	Office Attaches,	Highspire.
Erle county,	Selden, F. H.,	Cranesville.
Fulton county,	Jackson, R. L.,	McConnellsburg.
Indiana county,	Wehrle, R. W.,	Indiana.
Lancaster county,	Hertzog, P.,	Ephrata.
Luzerne county,	Good, Jacob,	Wapwallopen.
Lycoming county,	Allegar, I. L.,	Williamsport.
Monroe county,	Boyertown High School,	Shawnee.
Montgomery county,	Brunner, M. M.,	Boyertown.
Montgomery county,	West, Mrs. G. P.,	Iron Bridge.
Montour county,	Kinney, I. L.,	Danville.
Northampton county,	Stuart, Wm.,	Portland.
Perry county,	Andrews, F. S.,	Landisburg.
Tioga county,	Bean, I. T.,	Williamsport.
Venango county,	Couch, J.,	Emlenton.
Washington county,	Bullock, W. H.,	Canonsburg.
Wayne county,	Frey, Geo. T.,	Honesdale.
York county,		Emigsville.

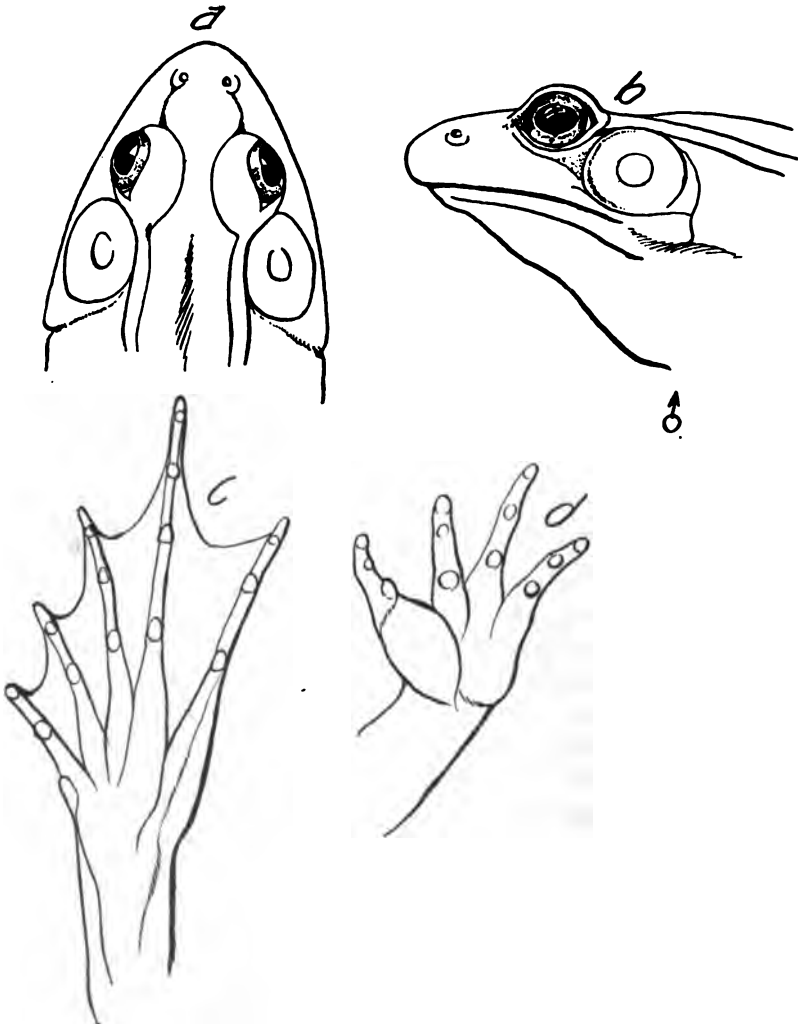


Fig. 24.—Structural characters of the Green Frog (*Rana clamitans*): a, dorsal view of head; b, lateral view; c, hind foot; d, fore foot. About 11-13 times natural size.

Original drawings from the Office of the State Zoologist.

The Green Frog is an aquatic form and, in this respect, stands second only to the Bull Frog. It is partial to bodies of water, ponds small streams and rivers—where it sits on the bank, hidden by the vegetation, but plunging into the water at the approach of danger. A common sound is a deep “chu-n-ng.” The croaking is “explosive, prolonged, and low-pitched and is likely to be repeated five or six times in succession. * * * It is given in shallow water”—(Dickerson).

The eggs are deposited in late March or April in large, firm masses of gelatinous material. The tadpoles are rather light in color, and may live two or three years before they assume the adult form. Tadpoles may reach a length of three inches. They are greedily eaten as food of fishes, and are used as bait.

The food found in 107 of 128 stomachs examined, consisted of earthworms, snails, crayfish, spiders, thousand-legged “worms,” grasshoppers, crickets, Lepidopterous larvæ, flies, ground beetles, May beetles, clover-leaf beetles, weevils, and wasps. The vegetable matter, including grass, was undoubtedly swallowed accidentally with the regular food. “Its food is small worms, or such insects as may come within its reach”—(Holbrook).

No. 30. *Rana catesbeana* Shaw. The Bull Frog.

The Bull Frog is variously known as “Bully,” “Bloody Nouns,” and “Jug-o’-rum.” The general color of the back is green or brownish green, marked with faint, dark spots. The green is generally palest over the head. The ear of the female is about as large as the eye, while that of the male is larger. The legs are marked with blotches, and the toes are broadly webbed. Adults reach a length of eight inches.

This species is found throughout the United States east of the Rocky Mountains. It is represented in our collection by 36 specimens from 10 counties:

Berks county,	Boyertown High School,	Boyertown.
Cumberland county,	Shick, H.,	Camp Hill.
Dauphin county,	Keboch, F. D.,	Williamstown.
Dauphin county,	Keboch, I.,	Berryburg.
Dauphin county,	Kecker, W. A.,	Harrisburg.
Dauphin county,	Shelly, D. W.,	Harrisburg.
Indiana county,	Wehrle, R. W.,	Indiana.
Lawrence county,	Hawthorne, L. H.,	New Castle.
Luzerne county,	Angus, Wm.,	Stoddardsville.
Monroe county,	Allegar, I. T.,	North Water Gap.
Perry county,	Kane, S. S.,	Landisburg.
Westmoreland county,	Myers, R. I.,	Wetty.
York county,	Frey, Geo. T.,	Emigsville.

The Bull Frog is the most aquatic of all our frogs and enjoys sitting with just the nose and eyes protruding above the surface of the water. Sluggish rivers and ponds, which furnish deep water for swimming and shallow water for sitting, are favorable places. Shores,

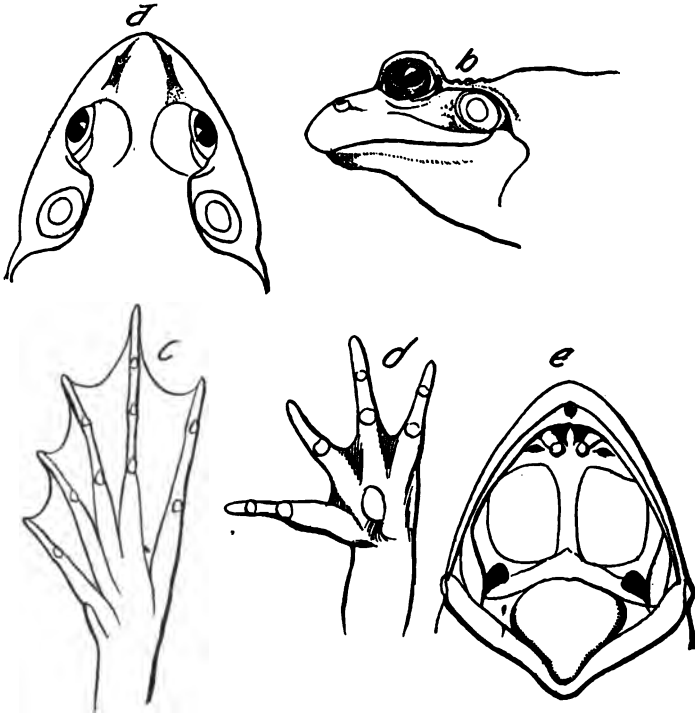


Fig. 25.—Structural characters of the Bull Frog (*Rana catesbeana*): a, dorsal view of head; b, lateral view; c, hind foot; d, fore foot; e, mouth laid open to show structure. About natural size.

Original drawings from the Office of the State Zoologist.

grown up with alders, willows, and other water-loving plants, furnish shade and concealment. The call of the male is deep, drawn out, and quivering, and may be repeated several times. The common name "Jug-o'-rum" is applied in imitation of this call. This is heard at night or during dark, rainy, weather. The Bull Frog often has a burrow in a bank, near which it sits, and to which it may retire for protection. As it can close its nostrils and breathe through the skin, the Bull Frog can remain under the surface of the water at pleasure.

The breeding season comes in May to July. The tadpoles, like those of the Green Frog, attain only partial development the first year and even the second, so that many do not assume the adult form until the third year. They are eaten by serpents and fish, used for bait, and protected by law in Pennsylvania.

"The Bull Frog feeds upon insects, and other small inhabitants of the pond. It also devours turtles, young water birds, and frogs, and any moving object that it can swallow or partially swallow"—(Dickerson). "Feed on various insects and the smaller animals

that live about water, as species of crawfish, also snails"—(Holbrook). "One stomach upon examination showed a number of caterpillars, three or four grass-hoppers, and a field mouse"—(Palmer). Of 39 stomachs examined in the laboratory of the Economic Zoologist, 29 contained food, which included earthworms, crayfish, spiders, water striders, beetles, weevils, ants and a young frog; also vegetable matter, such as a leaf and grass. They, and also turtles, have been known to feed on young ducks in ponds. They are captured by tying a piece of red flannel to a fish hook and swinging it over them as they perch in some spot favorable to their catching prey. They also devour small fishes, and when pressed by hunger are decided cannibals, as are all frogs. Frog culture or "Frog Farming" has been proposed, but no one has yet shown how to make it successful, owing chiefly to the cannibalistic tendency of these creatures, and the impossibility of supplying them artificially with an abundance of food when they are crowded together abnormally.

Stomach Contents of

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*The numbers correspond with those used in connection with the names of the species of amphibious given in the preceding pages.

Order Acarina (Mites),	1	2	1	1	19	2	2	1	8	1	7	21
Order Pseudoscorpiones (False Scorpions),												
Order Phalangidea (The Harvestmen),												
Class Myriapoda,												
Order Chilopoda (The Centipedes),												
Order Chilognatha (The Millipedes),												
Class Hexapoda (The Insects):												
Insect larvæ, undet.,	1	2	1	1								
Insects, undetermined,												
Nymphs, undetermined,												
Mayantra (Fish-moths, etc.),												
Mayanthura (Spring-tails),												
Chironomus (Spring-tails),												
Pedicia (Spring-tails),												
Ephemera (May flies),												
Ephemera nymph,												
Odonata (Dragon flies),												
Odonata nymph,												
Agrionidae (Damson flies),												
Plecoptera (Stone flies),												
Perlidae (Stone flies),												
Isoptera (Termites or white "ants"),												
Formicidae (Earwigs),												
Orthoptera, undetermined,												
Blattelle (Roaches),												
Acrididae (Short-horned Gr. Hp.),												
Tettigidea lateralis,												
Tettix sp.,												
M. femur-rubrum (Red-legged locust),												
Arphia sulphurea,												
Helanopius divitatus,												
Koccardia (L. H. Grasshoppers),												
Camelopardus sp.,												
Camelopardus sp.,												
Camel Cricket,												
Orchelimum sp.,												
Xiphidium sp.,												
Gryllide (Crickets),												
Gryllus sp.,												
Gryllus pennsylvanicus,												
Gryllus abbreviatus,												
Anaxiphus sp.,												
Nemobius sp.,												
Nemobius fasciatus,												
Geonothus sp. (Tree cricket),												
Physopoda (Thrips),												
Hemiptera, undetermined,												
Notonectidae (Water-batman),												
Naitha funicularis (Water-bug),												
Hydrotus (Water bug),												
Hydrotus renicula (Water-strider),												
Limnoretus rufoscutellatus (Strider),												

*The numbers correspond with those used in connection with the names of the species of amphibians given in the preceding pages.

Stomach Contents of

[illegible]

Stomach Contents of

Kind of Species by Number.*

Number examined.	19.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.
Number with recognizable food.	96	1	82	2	36	50	69	100	32	128	96
Number with matter undetermined.	52	1	58	.....	22	17	51	83	23	107	22
Inorganic matter (sand, clay, etc.).	10	.....	17	.....	3	6	3	9	4	9	4
Organic matter undetermined.	4	.....	1	.....	1	.....	2	9	1	14	3
Invertebrata found eaten by:							1	1	1	.....	1
Branch Annelata (Worms):											
Tapeworms,											
Nematodes,	1		1				6	6	1	4	.....
Gordius,											
Earthworms,											
Branch Mollusca (Mollusks):											
Class Gastropoda:											
Undetermined,											
Snails,											
Limax,											
Other Slugs,											
Class Lamellibranchiata (Bivalves):											
Mussels,											
Small Bivalves,											
Branch Crustacea (Crustaceans):											
Undetermined,											
Crayfish (Undt. sp.),											
Cumbarus sp.,							2	1			
Oniscellus sp. (Sow-bug),	1										
Shrimp,											
Class Arachnida (Spiders):											
Order Araneida (Spiders),					2	4	9	8	8	15	4
Family Lycosidae (The Running Spiders),	6		3				1	1		1	
Family Thomisidae (The Crab Spiders),											
Family Theridiidae (The Tube-weaving Spiders),											
Family Agelenidae (Funnel-web-weaving Spiders),											
Order Acarina (Mites),	1					1					
Order Pseudoscorpiones (False Scorpions),											

*The numbers correspond with those used in connection with the names of the species of amphibious given in the preceding pages.

POPULAR ERRORS CONCERNING AMPHIBIANS.

The class of Amphibians furnishes more than its share of popular errors or superstitions in Natural History. This may be because these creatures are more or less repulsive in appearance, and because they are generally, but wrongly, classed with Reptiles; and hence if they are hunted at all it is to kill them rather than to study them. Truth and fiction are so closely woven together in the human mind, that it is impossible to separate the two, and we can do nothing more than to attempt to render for mankind some service in correcting a few of the errors which he has popularly accepted and passed along. Among these are the mistakes embraced in the following corrections:

1. The tails of tadpoles do not drop off. They are gradually absorbed, and thus become sustenance to nourish the little animal during the time it is transforming from the aquatic and plant-eating form into the terrestrial and insectivorous or carnivorous creature.

2. Reptiles are not slimy, but Amphibians are generally moist or more or less slimy.

3. The slime of a cold blooded animal is not poisonous.

4. No Amphibians are venomous, or can poison by biting.

5. No Amphibians are poisonous or would produce any objectionable results by eating them.

6. Other parts of frogs than the hind legs are good to eat. In fact, there is no reason why the entire frog should not be eaten, as well as the entire parts of a squirrel.

7. Salamanders are good to eat. They should be skinned and prepared like frogs.

8. Frogs are cannibals. It is not generally known that they eat one another to a very great extent when confined in a closed space without sufficient food.

9. Frogs and toads do not rain down.

10. Frogs, toads, and other animals do not live enclosed in solid stone, etc., as is often reported.

11. Toads do not cause warts.

12. To kill a toad does not make the cows give bloody milk as is often said in the country.

13. There is no gem in the head of the toad, as was believed and published by the ancients.

14. The ashes of toads have no medicinal value whatever, neither do the ashes of any other creature.

15. Toads are among the most valuable insectivorous creatures of the gardens.

16. Salamanders are not fireproof, as was believed and published by the ancients.

17. To throw a salamander into fire will not put out fire, as is published in a popular powwow book in Pennsylvania.

18. The flesh of frogs is not especially highly nutritious, as is generally supposed.

19. Frog culture or "Frog Farming" is impractical, according to present knowledge of the subject, and has not proven successful at any place, excepting where

20. Salamanders, tadpoles, frogs, and other creatures do not poison nor in any way make harmful the water in springs, streams and wells where they may occur.

DEFINITIONS OF TERMS USED.

Amphicælian. Said of vertebræ which are concave both behind and in front.

Costal grooves. Grooves characteristic of salamanders, being depressions in the skin and generally showing the position of the rib beneath; hence called costal.

Disk. A rather spherical enlargement on the toes of tree frogs.

Dorsal. Of or pertaining to the back.

Keel. Provided with a ridge, or more properly fin-like development seen on the tail of salamanders and tadpoles.

Lateral. Pertaining to the side.

Longitudinal. Extending lengthwise.

Median. Extending along the middle.

Opisthocælian. Said of vertebræ which are concave behind only.

Ova. Latin word for eggs.

Ovum. Latin word for egg.

Palatines. Membrane bones of the roof of the mouth. They are two in number, one on each side and extending outward and backward from the vomer.

Parasphenoid. The bone of roof of the mouth behind the vomer.

Parotid. A glandular body behind the ear of amphibians.

Pedicle. The fleshy growth from the floor of the mouth by which the tongue is attached; said particularly of the tongue of salamanders.

Plumbeous. Lead-colored (from Latin *plumbum*, lead.)

Posterior. At or near the tail.

Sphenoid. Basal bone of the skull.

- Spiracle.* An opening in the neck and communicating with the gills.
Transverse. Extending across.
Vertebra. One of the bones of the spinal column.
Vomer. The bone which forms the front of the roof of the mouth.

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OF THE
DIVISION OF ZOOLOGY



OF THE
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VOL. III.—Combined Nos. 5 and 6.

SUBJECT: { **Some Pennsylvania
Birds and Their Eco-
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SEPTEMBER - NOVEMBER, 1913.

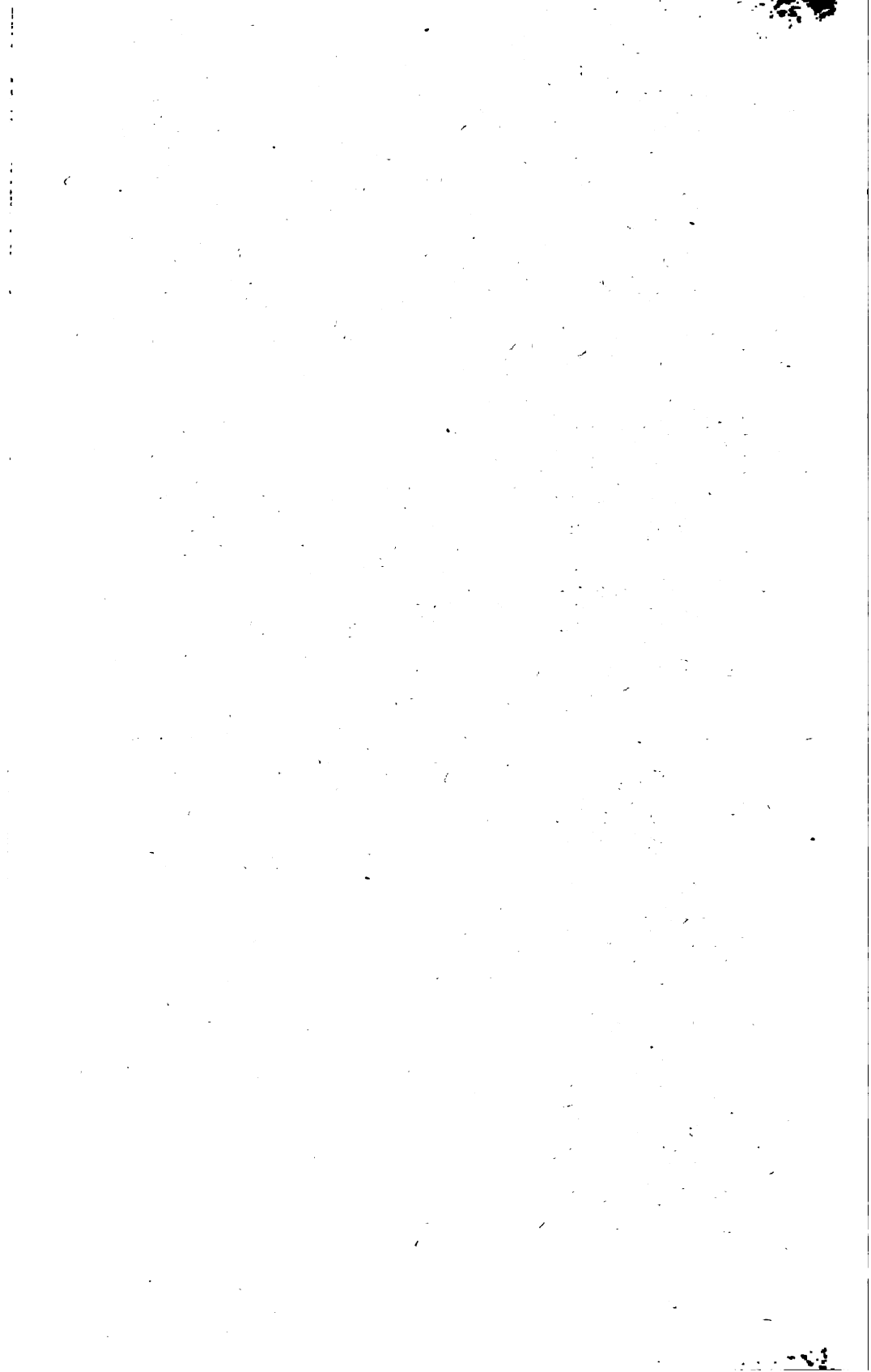
H. A. SURFACE, D. Sci., Economic Zoologist,
Editor

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PREFACE TO BIRD BULLETIN.

Readers who have been receiving the Bulletins of the Bureau of Zoology know that these have been on different topics, according to the needs of the season and the possibility of their preparation. A number of Bulletins have been issued on birds, beginning with the lowest orders and families, and discussing them in the systematic order of their classification. Our last Bird Bulletin was published in February, 1908, as Volume V, Number 10, of the Monthly Bulletin Series. However, those persons who have been preserving the Bird Bulletins will find it possible to put them together, and with this and subsequent Bulletins will have a complete publication on the species of birds occurring in Pennsylvania.

We have found it advisable to deal with each species of bird in more specific detail than in the former Bulletins. This naturally makes a larger Bulletin, but it gives the specific information that we wish to pass to the public concerning the habits of birds and specially their food and economic value.

This Bulletin, dealing chiefly with the families including the Larks, Crows and Sparrows, gives the results of investigations by this office and by the U. S. Biological Survey and others, and is, of course, reliable. It should be in the hands of every teacher and should be permanently preserved in every school room of the State, as well as in the homes where there are young people or others who care for nature studies. Any person in Pennsylvania wishing a number of these Bulletins for a school, grange, or other organization or society, can obtain them free by writing for them to the office of the Zoologist at Harrisburg.

In presenting this Bulletin to the public the State Zoologist takes pleasure in acknowledging the help that he has received through his present Assistant, Prof. John K. Musgrave, of Pittsburgh.

Other Bulletins on the subject of birds, including the families of the Tanagers, Vireos, Warblers, Wrens, Creepers, Titmice and Thrushes are in the course of preparation, and will be issued in the due course of time, thus completing our series of Bird Bulletins. When these are preserved and kept together one will thus have a detailed and complete publication on the Birds of Pennsylvania in reference to their habits and economy.

It is to be regretted that the supply of previously issued numbers is exhausted, and these can not be sent upon application; but all applications for the present Volume should be sent to the State Zoologist, Bureau of Zoology, Harrisburg, Pa.



ANALYTIC KEY FOR THE DETERMINATION OF THE ORDERS AND FAMILIES OF PENNSYLVANIA BIRDS.

Prepared by H. A. SURFACE, *Economic Zoologist.*

- A. Feet with all four toes connected by a continuous web; ORDER III STEGANOPODES. TOTIPALMATE BIRDS. FAMILY 5.—Phalacrocoracidae. Cormorants.
- AA. Feet with all four toes not connected by a web.
- B. Feet with the front toes (only) full-webbed, or toes with lobes of webbing at sides, and then claw flat and nail-like.
- C. Bill without teeth-like plates set on in a row along the sides; not broad at tip, but sharp-pointed.
- D. Legs far back, at "rump." ORD. 1.—PYGOPODES. THE DIVING BIRDS.
- e No tail feathers. FAM 1.—Podicipidae. The Grebes.
- ee Tail feathers present.
- f. Toes, four, FAM. 2.—Urinatoridae. Loons.
- ff. Toes, three, FAM. 3.—Alcidae. Auks, Murres, Etc.
- DD. Legs not far back on body. ORD. II.—LONGIPENNES. LONG-WINGED SWIMMERS. FAM. 4.—Laridae. Gulls and Terns.
- CC. Bill with teeth-like plates along the sides, as in a duck, broad (depressed). ORD. IV.—ANSERES. "PLATE-TOOTHED" SWIMMERS. FAM. 6.—Anatidae. Ducks, Geese and Swans.
- BB. Front toes not full-webbed.
- F. Legs long; tibia naked below; waders.
- G. Hind toes well developed and level with the others. Middle claw with teeth on one side. ORD. V.—HERODIONES. HERONS, STORKS, ETC. FAM. 7.—Ardeidae. Herons, Bitterns, Etc.
- GG. Hind toes (if present) small and above level of others. Middle claw without teeth.
- H. Hind toe never absent, but little above level of others. Bill never sensitive; wings short and rounded. ORD. VI.—PALUDICOLÆ. CRANES, RAILS, ETC. FAM. 8.—Rallidae. Rails, Gallinules and Coots.
- HH. Hind toe (when present) quite above level of others. Bill sometimes very sensitive, soft and flexible toward the tip. ORD. VII.—LIMICOLÆ. THE SHORE-BIRDS.
- i. Tarsus (i. e., portion of leg just above foot) scutellate (with regular broad plates, in vertical series) in front. Bill slender, flexible, sensitive, with a blunt tip. FAM. 9.—Scolopacidae. Snipes and Sandpipers.
- ii. Tarsus reticulate (with regular net-like markings) in front. Bill with sharp tip, not soft and sensitive. FAM. 10.—Charadriidae. Plovers.
- FF. Legs not elongate; tibia (i. e. "the drum stick") full feathered; not waders.
- J. Bill strongly hooked and with a fleshy cere at base. ORD. VIII.—RAPTORES. THE BIRDS OF PREY.
- k. Head naked, hind toe with a short dull claw. FAM. 11.—Cathartidae. Vultures.
- kk. Head feathered, and hind toe long and sharp.
- l. Eyes directed sidewise and not surrounded by a disk of radiating feathers. FAM. 12.—Falconidae. Kites, Hawks, Eagles, etc.
- ll. Eyes directed forward, and surrounded by a disk of radiating feathers.
- m. Middle claw with comb on inner edge. FAM. 13.—Strigidae. Barn Owls.

- mm. Middle claw with no comb. FAM. 14.—Bubonidæ. Owls.
- JJ. Bill without both strong hook and cere at the same time.
- L. Hind toe short, slightly elevated; the front toes more or less connected at base by a small webbing. ORD. IX.—GALLINÆ. THE "CHICKEN-LIKE" BIRDS. FAM. 15.—Tetraonidæ. Grouse and Quail.
- LL. Hind toe not short and elevated.
- M. Bill cered but not strong and hooked. ODR. X.—COLUMBÆ. PIGEONS AND DOVES. FAM. 16.—Columbidæ. Pigeons and Doves.
- MM. Bill not cered.
- N. Hind claw not quite as long as the longest of the anterior (front) claws.
- O. Toes, two in front and two behind; or the outer and middle toes united.
- P. Tail feathers soft. ORD. XI.—COCCYGES. CUCKOO-LIKE BIRDS.
- q. Toes, two in front, two behind. FAM. 17.—Cuculidæ. Cuckoos.
- qq. Toes, three in front, one behind, outer and middle grown together half their length. FAM. 18.—Alcedinidæ. Kingfishers.
- PP. Tail feathers rigid, pointed at tips. ORD. XII.—PICI. WOODPECKERS. FAM. 19.—Picidæ. Woodpeckers.
- OO. Toes three in front and one behind, and outer and middle never united. Mouth with wide gape (opening) and short bill; or bill very long and slender. ORD. XIII.—MACROCHIRES. GOATSUCKERS, SWIFTS AND HUMMING BIRDS.
- r. Bill short and broad at base.
- s. Middle claw toothed. FAM. 20.—Caprimulgidæ. Goatsuckers, Etc.
- ss. Middle claw not toothed. FAM. 21.—Micropodidæ. Swifts.
- rr. Bill very long and slender. FAM. 22.—Trochilidæ. Humming Birds.
- NN. Hind claw as long or longer than the middle front claw. Toes always three in front, one behind. ORD. XIV.—PASSERES. PERCHING BIRDS.
- t. Tarsus with its hinder edge rounded.
- u. Bill with a hook at tip and long bristles at base. Hind claw curved and not extra long. FAM. 23.—Tyrannidæ. Flycatchers.
- uu. Hind claw straight and very long. FAM. 24.—Alaudidæ. Larks.
- tt. Tarsus with its hinder edge sharply compressed.
- v. Apparently but nine primaries (i. e., the long feathers on the "outer joint" of the wing) present; (the first minute and displaced); the first that is developed is about as long as the next; bill not hooked at tip.
- w. Bill with but ordinarily wide gape.
- x. Bill strong, with an angle in the cutting edge near the base of the upper mandible, with the corners of the mouth drawn downward (=conirostral).
- y. Bill rather long, sharp pointed, no notch at tip nor bristles at base. FAM. 27.—Icteridæ. Orioles and Blackbirds.
- yy. Bill short, often notched at tip, and usually with bristles at base. FAM. 28.—Fringillidæ. Finches, Sparrows, Etc.
- xx. Bill not "conirostral" (not as in "X"); no downward angle of the mouth near the base of the upper bill.
- z. Bill strong, upper mandible (bill) slightly toothed near its middle. Plumage mostly red. FAM. 29.—Tanagridæ. Tanagers.
- zz. Bill rather slender, not strongly conical.
- &. Hind claw much shorter than its toe. FAM. 34.—Mniotiltidæ. Warblers.
- &&. Hind claw as long as its toe. FAM. 35.—Motacillidæ. Pipits.
- ww. Bill with very wide gape. Wings pointed. FAM. 30.—Hirundinidæ. Swallows.
- vv. Primaries evidently ten, the first developed, but short, rarely half the length of the next; or tip of bill hooked.
- a. Tarsus distinctly covered with regular scales in front, i. e., scutellate.
- b. Tarsus short; gill short, depressed; head crested; tail tipped with yellow. FAM. 31.—Ampelidæ. Waxwings.
- bb. Tarsus longer than middle toe and claw; or other characters differing from above (b).
- c. Bill both strongly hooked and toothed. FAM. 32.—Laniidæ. Shrikes.
- cc. Bill without both strong hook and tooth.
- d. Bill slightly hooked at tip. FAM. 33.—Vireonidæ. Vireos.

- dd. Bill not hooked at tip.
- e. Tail feathers stiff, pointed. Bill long, decurved. FAM. 37—Certhiidae Creepers.
- ee. Tail feathers soft and rounded at tip.
- f. Nasal feathers directed forward, usually covering the nostrils.
- g. Birds of medium or large size. Wing more than four inches long. FAM. 25—Corvidae. Crows and Jays.
- gg. Birds of small size. Wing less than four inches long.
- h. Bill not notched. FAM. 38—Paridae. Titmice and Nuthatches.
- hh. Bill notched toward the tip, very slender. FAM. 39—Sylviidae. Kinglets.
- ff. Nasal feathers erect or directed backward, not covering nostrils; bill rather slender, the upper side convex. FAM. 36—Troglodytidae. Wrens and Mocking Birds.
- aa. Tarsus "booted" (i. e., smooth in front, without distinct scales or cross lines, except near the base); bristles present at base of bill.
- i. Birds of small size; wing less than three inches long; young unspotted. FAM. 39—Sylviidae. Kinglets and Gnatcatchers.
- ii. Birds of medium size; wing more than three inches long; young spotted. FAM. 40—Turdidae. Thrushes.

The above "Key" is intended to be useful in giving readers a "bird's eye view" of the classification that includes nearly all American birds. It is unfortunate that in identifying a bird by this "Key" only a specimen in the hand can be used, but many birds are found dead, and these can be utilized in a scientific examination. No one should kill birds for this purpose. It is illegal even for collecting, unless done by obtaining a properly issued license.

An effort has been made to keep the "Key" free from scientific terms, but to a certain limit this is impossible. It is just as though one should attempt to take from a machine all the parts that a person who is not a mechanic would not understand.

The Class of Birds or Aves, is divided into large groups called Orders. These Orders are designated in the "Key" by Roman numerals. They are in turn divided into smaller divisions called Families, here numbered with Arabic numerals. This is slightly different from botanical classification, in which the terms, "order" and "family" are used for the same group, as equivalents.

We have designated the steps to Orders by capitals, and from Orders to Families by lower case letters. In using the "Key" to find the name of the Family to which a specimen in hand belongs it must be understood that it goes to one or the other of two roads or divisions. It is either "A" or "AA," then if it goes to "AA" it belongs to "B" or "BB," if to the former it must come either to "C" or "CC," but if to the latter ("BB") it belongs under "F" or "FF." For example, suppose we have in hand the specimen we once found dead, and preserved it. We examine it and find that all the toes are not connected by a web, so it goes to "AA." In fact, the front toes are not full webbed, so it goes to "BB;" and as the legs are not especially long and the tibia is fully covered with feathers below,

we know it is not a wader, and it consequently belongs under "FF." The bill does not have both a strong hook and cere, so it goes to "JJ," and it does not have a short and elevated hind toe it goes to "LL." The bill has no cere, so it belongs to "MM," and as the longest claw is in front it goes to "N." The toes are "two in front and two behind," so it belongs under "O," and as the tail feathers are stiff and pointed at the tips it goes to "PP." Now as we can run it down no further it must belong to "Order XII. PICI. WOODPECKERS." As there is only one American Family in this order, it belongs to the Family Picidæ or Woodpeckers.

It must be remembered that in every case throughout the "Key," a name belongs with the line before it rather than to the one following it.

FAMILY 24. ALAUDIDÆ. The Larks.

The second family of the Passerine, or perching, birds is known as Alaudidæ and includes the true Larks. These birds may be recognized by the following characters: bill rather stout and rounded; claw of the hind toe much lengthened, as long as the middle toe without the nail; back of tarsus rounded like the front; first primary very short or obsolete.

About 100 species are known, chiefly birds of the Old World. The most famous bird of the family, is the Sky Lark, *Alauda arvensis* L., of Europe. In America the family is represented by one genus, *Otocoris*. Indeed, all the forms which occur in North America belong to one species, namely *Otocoris alpestris*, but this runs into some twenty-one varieties or subspecies. These varieties are due to living under different conditions: some varieties are birds of the beaches and salt-marshes of the coast, others of lake shores, muddy flats, and swamps of the interior; in the far West, of hot desert valleys, arid table lands, level, grassy prairies, the foothills, and even bare mountain-tops. In Pennsylvania there occur the typical *Otocoris alpestris*, the Horned Lark, and *Otocoris alpestris praticola*, the Prairie Horned Lark.

Our Larks are ground-loving birds which frequent cultivated fields, waste places, meadows and road-sides. Except during the breeding season they are gregarious, and are found in great flocks during the fall and winter. Since the ocean shore is a common place of sojourn at that time of year, these birds have been called Shore-larks. However, the majority of the varieties are birds of the interior, so the name "Shore-lark" is not applicable to all members of the genus *Otocoris*. However, all these birds have a tuft of black or dark colored feathers above and behind each eye, so the name "Horned Lark" is fitting and should be applied to these birds.

474.* *Otocoris alpestris* (Linn.). The Horned Lark.

The typical Horned Lark is pinkish brown with numerous streaks; black crescent on breast; *black tuft of feathers above each eye* forming the "horn;" white below; chin, throat and line over eye sulphur yellow. Adults are about 7½ inches long; tail 3 inches.

Breeds in Northern Europe, Greenland and Northeastern Canada; migrates southward in winter into Eastern United States as far as North Carolina and Tennessee. It is not readily distinguished in the field from the following, which it resembles in habits.

*The numbers here used are those of the check list of the American Ornithologists' Union.

474b. *Otocoris alpestris praticola* Henshw. The Prairie Horned Lark.

Similar to the typical *O. alpestris*, slightly smaller and paler, the yellow being largely replaced by white. See plate II facing page 162.

Annual resident of Pennsylvania. Breeds in the Upper Mississippi Valley, eastward through New York to Western Massachusetts and Long Island. Young seen in Blair Co., Pa., in May, 1914. H. A. S.

Like other Horned Larks it is a hardy bird, seeming to take delight in braving the cold weather and in living in exposed situations. It *runs* along the ground, and when frightened takes wing hesitatingly, utters a sharp whistle, and, like the Spotted Sandpiper, returns to the starting point or flies off to a place of safety. Although our Horned Larks are not as famous songsters as is the European Sky Lark, they sing much as the latter bird. This song is heard during the nesting season, and often is sung as the bird rises in the air and soars so high as to become invisible. "****But it often utters the same song while perched on some clod or stone, especially just before dawn or after sunset, as well as in the spring time, while the snow is on the ground" (Ernest E. Thompson).

The nest is usually made of grasses which fill small cavities in the surface of the ground. Nesting season begins very early, often before the snow has disappeared, and two or three broods may be reared in a year. Eggs average three to four in number; pale bluish or greenish white, minutely and evenly speckled with pale grayish brown; size .84 x .60 inch.

A very complete account of "the Horned Larks and Their Relation to Agriculture" forms the contents of Bulletin 23 of the Bureau of Biological Survey, U. S. Department of Agriculture, published in 1905. Investigation by that bureau shows that with the exception of the California subspecies *O. a. actia*, the food of the Horned Larks is almost identical. Eleven hundred and fifty-nine stomachs were collected in all parts of the United States and the examination shows that 20.6% of the food is insects and 79.4%, vegetable matter, nearly six-sevenths of which are weed seed.

"It is impossible to estimate in dollars and cents the benefits resulting from the work of the Horned Lark, but it is none the less real on that account. Moreover, the services of the bird cost the farmer practically nothing save a small toll levied here and there upon seed grain. So small in amount is the grain thus taken and over such restricted areas that, aside from the fact that at small expense all damage can be prevented, the loss bears no comparison to the benefits conferred. The Horned Lark by its services to agriculture earns a right to live and deserves protection at the hands of man."



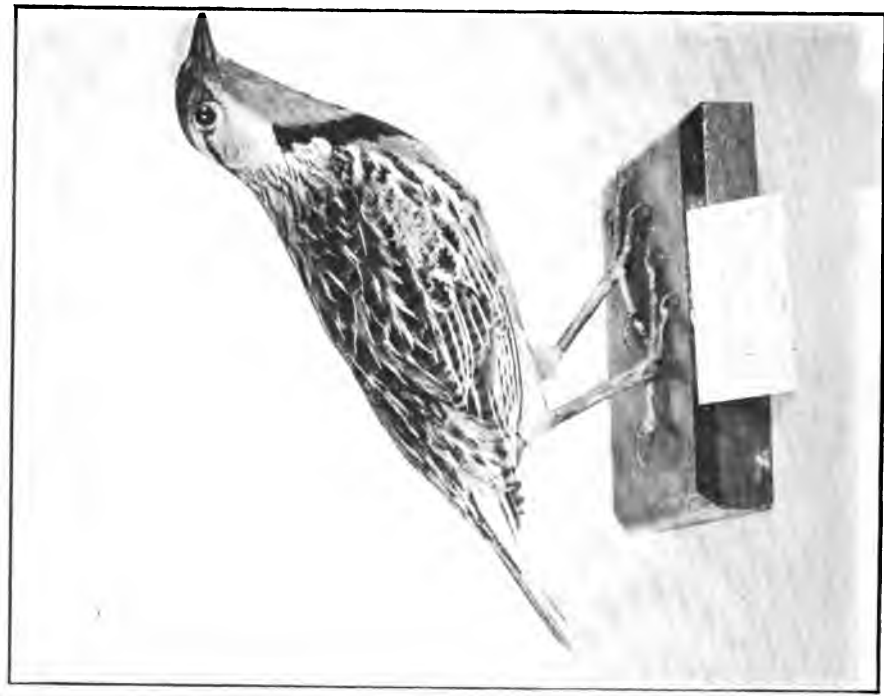
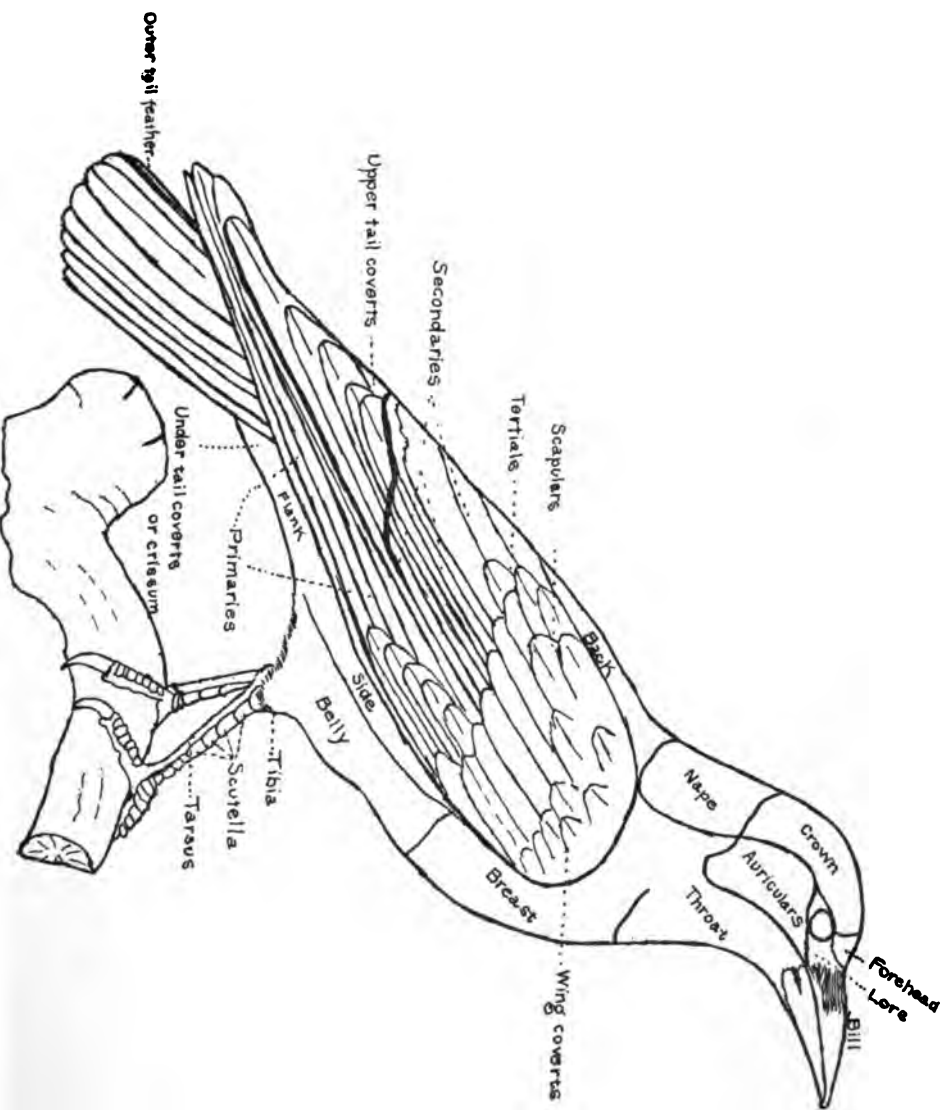


Plate 11. The Prairie Horned Lark (left) and the Meadow Lark (right). This plate and subsequent ones, unless otherwise noted, in this bulletin made from original photographs for the Economic Zoologist from mounted specimens in the Academy of Natural Sciences, Philadelphia, Pa., by the kind permission of Dr. Witmer Stone.



Topography of a Bird (American Crow).

FAMILY 25. CORVIDÆ. The Crows, Jays, Etc.

The birds of the family Corvidæ are large ones, measuring ten inches or more in length; bill stout, rather long, nostrils concealed by tufts of bristly feathers, which point forwards; outer tail feathers shortest.

Two hundred species described, some in almost all parts of the world. In Pennsylvania five species are found.

All our species, with the exception of the Canada Jay, are resident throughout the year, and, except during the breeding season, are gregarious. Also, more or less migratory, especially the Crow. Although the Corvidæ are not songsters they show remarkable inflections of voice, and some students of birds place the Corvidæ in the front rank of bird intelligence.

KEY TO THE PENNSYLVANIA SPECIES OF CORVIDÆ.

A. Plumage black.

- a. Wing about 15 inches long; bill over $2\frac{1}{2}$ inches, 486a.
Raven, page 165.
- b. Wing about 13 inches long; bill about 2 inches, 488.
American Crow, page 166.
- c. Wing about 11 inches long; bill about $1\frac{1}{2}$ inches, 490.
Fish Crow, page 168.

B. Plumage bluish or grayish.

- a. Back blue; tail tipped with white; black breast patch, 477.
Blue Jay, page 163.
- b. Back gray; back of the head and nape blackish; fore-head whitish, 484. *Canada Jay*, page 164.

477. *Cyanocitta cristata* (Linn.). The Blue Jay.

The prevailing color of the Blue Jay is grayish blue; band across breast, back of head and sides of neck, black; wings and tail clear blue, barred with black; outer tail feathers and secondaries tipped with white. Adults 12 inches in length, tail about 6 inches, bill slightly more than 1 inch in length. See plate III facing page 166.

The Blue Jay is a common bird throughout Eastern North America. It may be found in woodlands, orchards, fields, or even about dwellings. Because of its bright coloration and aggressive, noisy manner, few birds are more conspicuous. During the fall and winter, when the leaves have fallen, the Jays are especially busy gathering

and storing food. When snow covers the ground they come about dwellings in search of food. It is not a singer, but imitates other birds, particularly the commoner Hawks.

The nest is made of rootlets in May in the crotch of a tree. Eggs four to six; pale olive green to brownish ashy in color, rather thickly marked with distinct or obscure spots of varying shades of cinnamon brown; size 1.10 x .85 inch.

The food of the Blue Jay is divisible into vegetable (75.7%) and animal (24.3%). The former is made up of fruits, grains, and other seeds. Among these are mast,—acorns, chestnuts, beechnuts, and hazlenuts. The bulk of the grain, which is waste, is picked up in fields after harvest or found during the winter. Corn forms 17.9% of the food, and the bulk of this is eaten in January. The Jay prefers mast to grain and, furthermore, unlike the Crows, Crow Blackbirds, and some Woodpeckers, it does not eat regularly the seeds of the poisonous species of *Rhus* (poison ivy and sumacs), and thus does not disseminate these seeds.

The habit of the Blue jay in eating eggs and nestling birds has been much commented upon. Prof. Beal shows in his report in the 1896 Yearbook of the United States Department of Agriculture (pp. 199-200) that 292 stomachs were examined by the Bureau of Biological Survey and remains of small birds' eggs were found in two only and the shells in three. One stomach taken in February contained remnants of a bird.

The animal food is made up largely of insects. These are eaten every month in the year, in greatest amount in the warmer months when insects are more abundant. The bulk of the insect food consists of beetles, grasshoppers, and caterpillars, with a few bugs, wasps, flies, and an occasional spider or myriapod.

484. *Perisoreus canadensis* (Linn.). The Canada Jay; Whiskey Jack.

Fore part of head white; back of head and nape sooty black, back gray; wings and tail gray, most feathers narrowly tipped with white; throat and sides of the neck white, rest of the under parts ashy gray; length 12 inches.

Nova Scotia, Northern New England, and Northern New York; west to northern Minnesota; north, in the interior, to the arctic regions. "Very rare straggler in winter" in Pennsylvania. "Dr. A. C. Treichler secured one, February 1889, in Lancaster County, Pa." (Stone).

The nest is composed of coarse twigs and strips of bark and is placed in coniferous trees. Eggs, 4-5; white, distinctly and obscurely spotted with light olive-brown; 1.5 x .81 inch.

Food: "Like the ordinary Jay they are hoarders. Audubon says they store away berries and nuts in hollow trees, or between the layers of bark on decaying branches, the provision secured enabling them to pass the winter in comfort and rear their young before the snow is off the ground."

486a. *Corvus corax principalis* Ridgw. The Northern Raven.

The Northern Raven may be distinguished from the Crow by its greater size (adults average 25 inches in length); the entire plumage is black, with steel blue reflections, and the feathers of the throat are stiffened, elongated and narrow.

The Raven is found in the northern parts of North America but is rare east of the Mississippi River. An occasional pair or colony is found in the higher or more northern and secluded parts of Pennsylvania. The writer has seen them nesting in Centre County (1900 to 1910).

This bird very much resembles the Crow in habits, and may be looked upon as a large Crow. The voice, however, is deep and hoarse, the usual call being much like that of a young Crow, and may be represented thus: cr-r-r-cruck.

The nesting season begins early, as we have found the young in Centre County, Pa., as large as full grown Crows about the middle of April. The nest is compact, like that of a Crow, and is placed in a high tree or on a cliff. The eggs number two to seven and are marked like those of the Crow; size 2.02 x 1.38 inches.

Nothing in detail has been published on the food of the Raven, but there is every reason to believe that the food is similar to that of the Crow. Of course, the more retiring habits of the Raven and its occurrence in the more unsettled regions would result in some differences in food. "Largely fish offal and refuse; also clams and eggs and young of waterfowl" (F. M. Bailey).

Vernon Bailey in writing of the American Raven, *C. c. sinuatus*, says, "They descend to lake and river shores for dead fish or whatever the waves wash up in the way of food, make a few meals from a dead sheep, feast on what is left when a hunter dresses a deer and are accused of helping out their varied bill of fare with eggs and young from any birds' nest that comes handy. Their own nest, placed in a niche half way up some perpendicular cliff, usually bids defiance to all enemies."

488. *Corvus brachyrhynchos* Brehm. The American Crow.

The Crow is uniformly black with steel blue or deep purplish reflections, most pronounced on the body; length about 20 inches. See plate III facing page 166.

Found throughout North America, but the Canadian Crows generally migrate in the fall to the Northern United States. Even our Pennsylvania birds move more or less southward and congregate in great flocks in winter, often near bodies of water. These congregations assemble in rookeries, some of which are very extensive so as to include upwards of 200,000 birds. From these rookeries the crows disseminate at dawn and to them they repair at night. Great numbers of Crows are observed in winter along the coast, where they find sustenance in the dead fish and other debris of the washup.

Large Crow roosts known to be in use in Pennsylvania during 1886 and 1887 are recorded in Bulletin 6 of the U. S. Bureau of Biological Survey as follows:

Locality.	Extent.	Number of Crows.
Coatesville, Chester county,	Several acres	.....
Davis Grove, Montgomery county,	About 20 acres	200,000
Lancaster, Lancaster county, .....	.....	Large numbers

There are other large roosts near Garver Ferry, Westmoreland County (at the junction of the Allegheny and Kiskiminitas Rivers) and Bristol, Bucks County.

Crows, like their cousins the Blue Jays, have held their own despite the persecution to which they have been subjected. Their numbers have scarcely diminished because they have adjusted themselves to the encroachment of man, as they are shy and suspicious but aggressive.

The nest is usually placed high in a rather inaccessible place in a tree early in April. In selecting the site the Crow shows its usual wariness and sagacity. The eggs number four to six, and are generally bluish green, thickly marked with shades of brown; size 1.65 x 1.19 inches.

The Bureau of Biological Survey examined 909 stomachs of Crows, and the results of the investigations are embodied in Bulletin No. 6, published in 1895. The stomach contents average 36.6% animal food and 63.4% vegetable food. If, however, the mineral matter be taken into consideration the averages are: mineral matter 10.3%, animal matter 32.9% and vegetable matter 56.8%.

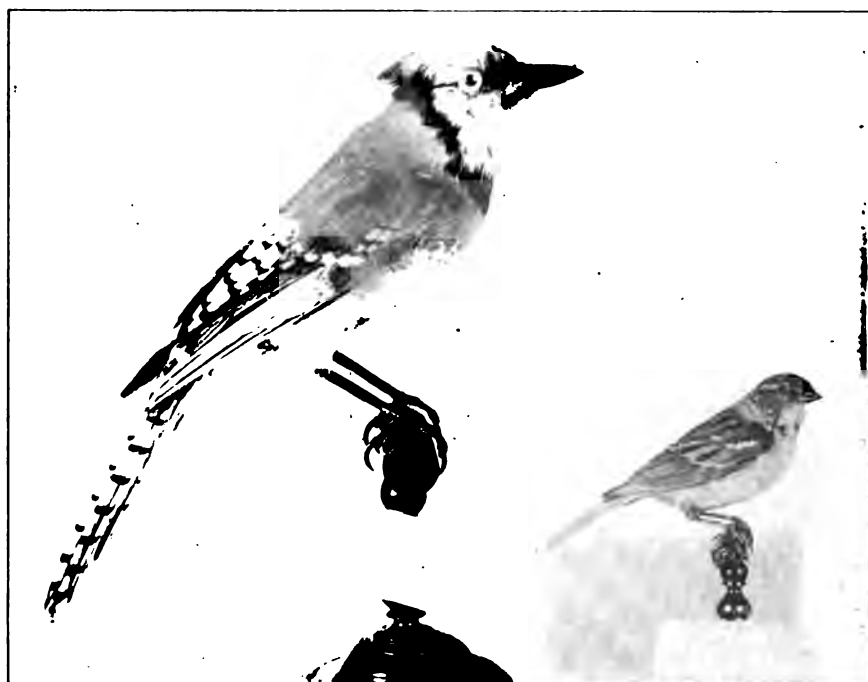
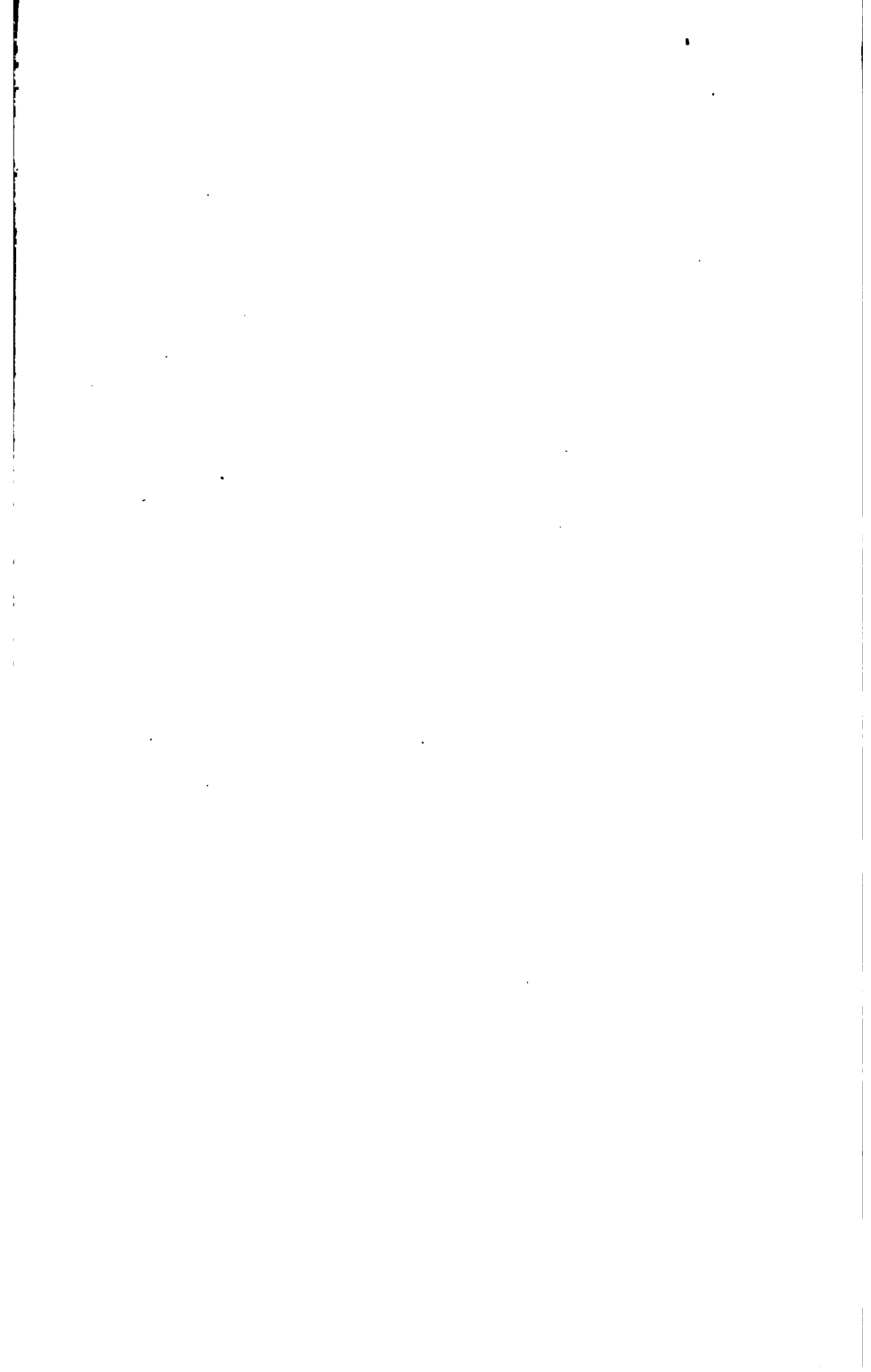


Plate III. The American Crow (upper figure), The Blue-jay (lower figure, left) and the Chipping Sparrow (lower figure, right).



Plate IV. The Bronzed Grackle.



Dr. C. Hart Merriam, former Chief of the Bureau of Biological Survey says: "The most important charges brought against the Crow are: (1) That it pulls sprouting corn; (2) that it injures corn in the milk; (3) that it destroys cultivated fruit; and (4) that it feeds on the eggs and young of poultry and wild birds."

"All of these charges are sustained by the stomach examination so far as the simple fact that Crows feed upon the substances named. But the extent of the injury is a very different matter."

"In order to ascertain whether the sum of the harm done outweighs the sum of the good, or the contrary, the different kinds of food found in the stomachs have been reduced to quantitative percentages and contrasted. The total quantity of corn eaten during the entire year amounts to 25% of the food of adult Crows, and only 9.3 per cent. of the food of young Crows. Leaving the young out of consideration, it may be said that in agricultural districts about one-fourth of the food of Crows is corn. But less than 14 per cent. of this corn and only 3 per cent. of the total food of the Crow consists of sprouting corn and corn in the milk; the remaining 86 per cent. of the corn, or 97 per cent. of the total food, is chiefly waste grain picked up here and there, mainly in winter, and of no economic value."

"In the case of cultivated fruits the loss is trivial. The same is true of the eggs and young of poultry and wild birds, the total for the year amounting to only 1 per cent. of the food."

The animal food includes mammals, birds, reptiles, batrachians, fish, crustaceans, mollusks, insects, and spiders. Of 909 stomachs examined 38 contained remains of rabbits and Mr. Barrows says these were mostly taken in May and that undoubtedly most of them had been taken alive. Carrion forms a large part of the animal food, while mice, especially the short-tailed field mice (*Microtus*) are important.

Of reptiles, small tortoises, snakes and lizards are eaten. The snakes are all of harmless species which are beneficial because they destroy insect pests. Lizards are seldom taken, due to their very rapid movements and protective coloration.

Crows consume great numbers of toads and frogs, an unfortunate fact since the former are particularly beneficial to farmers.

The contents of Crows' stomachs show that less than 1 per cent. is fish, and this is mostly carrion. However, Crows are known to be fairly good fishers especially during the winter.

Of crayfish or crawfish Crows consume great numbers and, indeed, these crustaceans are almost regularly an article of diet, the annual average being 1 per cent. Along the seashore large numbers of crustaceans, both alive and dead, are taken. Occasionally land snails and mussels are eaten.

"The facts on the whole overwhelmingly speak in favor of the Crow, and taken alone would be at variance with the prevalent opinion hitherto held and yet held regarding the economic status of the Crow as an insectivorous bird."

In view of the fact that Crows frequently cause damage by pulling sprouting corn, a method of protecting corn against such ravages is timely. Place the shelled seed corn in a vessel of suitable size and pour in sufficient warm water to cover the corn. Allow the grain to soak for sometime. Then add sufficient coal tar so that when the whole is stirred each kernel is lightly covered. Add air-slacked lime, fine dry earth, or sifted ashes and mix thoroughly. The corn when planted is so distasteful to Crows that after a few attempts they will leave the field.

Some growers prefer to scatter corn over the field so that the Crows will eat it and not disturb the seed. The supply should be replenished as often as is found necessary until the corn has grown sufficiently to be beyond danger.

490. *Corvus ossifragus* Wils. The Fish Crow.

The entire plumage of the Fish Crow is black with steel-blue or deep purplish reflections, generally more greenish on the under parts; length 16.00 inches.

The Fish Crow is found along the Gulf and Atlantic Coasts, as far north as southern Connecticut, and is resident except at the extreme northern part of the range. "Found along the Delaware River at least as far up as Philadelphia and may breed sparingly in Delaware County, Pennsylvania. It is also reported to ascend the Susquehanna River as far as the Pennsylvania line." (Stone).

The writer has seen a specimen collected along the Susquehanna River near Harrisburg.

The nest is generally built of sticks, lined with strips of grapevine bark, moss, grasses, etc., usually in pines or cedars, twenty to thirty feet up. The eggs are four to six in number and similar to those of the Common Crow; size 1.52 inches x 1.06 inches.

The Fish Crow's call is cracked, nasal and reedy, much like that of young American Crows.

These are birds whose life is so closely allied with that of the sea coast, and which are of such small numbers in this State, that to us they are of little economic importance here.

FAMILY 26. STURNIDÆ. The Starlings.

The Sturnidæ comprise an Old World family of birds, of which there are about 200 species. They are characterized by a flattened bill; short, square tail; long, pointed wings; second primary longest, the first being less than one-half an inch in length. The Starling, which has been introduced into this country, is the only representative of the family we have.

493. *Sturnus vulgaris* Linn. The Starling.

The ground color of the Starling is metallic purplish or greenish; feathers of the upper parts all tipped with cream-buff spots; feathers of the under parts marked only on the sides; lower belly and under tail coverts, wings, and tail dark brownish gray, edged with cream buff; bill yellow. *Adult in winter* similar but the upper parts heavily spotted with brownish cream-buff; the entire under parts heavily spotted with white; bill blackish brown. Length 8.5 inches. See plate V facing page 172.

The Starling is found in Europe and Northern Asia and is accidental in Greenland.

The nest of grasses, twigs, etc. is placed in a crevice in a building or hollow tree. Eggs four to six; pale bluish; 1.25 inches x .86 inch.

In the Yearbook of the U. S. Department of Agriculture for 1898 Dr. T. S. Palmer gives the following:

"It (the Starling) is sometimes accused of stealing fruit and destroying nests and eggs of other birds, but in its native home it seems to be beneficial rather than otherwise. Comparatively little accurate information concerning its food habits is available, except the results of an examination of 175 stomachs recently made in Scotland by Mr. John Gilmour. According to this examination the food consists of 75 per cent. insects, 20 per cent. grain (mainly waste grain), and 5 per cent. miscellaneous substances. Some useful insects are eaten, but the greater proportion were classed as injurious. The charge of destroying eggs of larks, and occasionally young nestlings, was not substantiated, as no eggs shells were found in these stomachs. Mr. Gilmour * * * * concludes that on the whole the bird is beneficial and worthy of protection."

However, the consensus of opinion in the United States is that the Starling is undesirable, and as Pennsylvania does not give it legal protection it may be killed at any time.

FAMILY 27. ICTERIDÆ. The Blackbirds, Orioles, Etc.

The family Icteridæ consists of birds of medium size, characterized by the facts that the nostrils are not concealed by bristles, and the base of bill extends backward and is divided by the feathers of the forehead.

This family is confined to America, where the number of species increases toward the Equator. About 150 species have been described and 29 species and sub-species are found in the United States. In Pennsylvania the Icteridæ are represented by 10 species and sub-species, most of which are pretty well distributed over the Commonwealth. Of these, 7 are summer residents only; the Meadow Lark is a permanent resident in the southern section, a considerable number of the birds remaining there during the winter; while the Rusty Blackbird is a transient only, passing through the State in the spring and fall migrations, and the Yellow-Headed Blackbird is a very rare straggler (one record: marshes below Philadelphia, 1851).

All of the Icteridæ, with the exception of the Orioles, are gregarious except during the nesting season. The colonial habit of the Blackbirds is well known to all who are familiar with these birds. The Meadowlarks are birds of the fields, the Red-winged Blackbird is partial to the swamps and the borders of ponds and streams; while the Orioles are birds of shade, orchard, and woodland trees. The Orioles, Bobolink, Meadow Lark, and Red-winged Blackbird are singers but the Grackles utter coarse, guttural sounds only.

KEY TO THE PENNSYLVANIA SPECIES OF ICTERIDÆ.

- I. Yellow or orange in the underparts.
 - A. Throat black. 507. *Baltimore Oriole*, page 176.
 - B. A black or blackish crescent on breast. 501. *Meadowlark*, page 174.
 - C. Throat and breast yellow or yellowish, belly black, or dark grayish brown. 497. *Yellow-headed Blackbird*, page 173.
- II. Under parts black, with or without metallic reflections.
 - A. Outer tail feathers $\frac{3}{4}$ inch shorter than middle ones; bill one inch or more in length.
 - a. Back bronzy purple, or shining brassy bluish green, the feathers with iridescent bars. 511. *Purple Grackle*, page 177.
 - b. Back bronze without iridescent bars. 511b. *Bronzed Grackle*, page 178.

B. Outer tail feathers little if any shorter than middle ones, bill less than one inch in length.

a. Entire plumage bluish black, the feathers sometimes tipped with rufous or buffy. 509. *Rusty Blackbird*, page 176.

b. A bright red and buff shoulder patch. 498. *Red-winged Blackbird*, page 173.

c. Head and neck all around seal brown. 495. *Cowbird*, page 172.

d. Nape buffy, rump whitish. 494. *Bobolink*, page 171.

III. Under parts chestnut; throat black. 506. *Orchard Oriole*, page 175.

494. *Dolichonyx oryzivorus* (Linn.). The Bobolink, Ricebird, Reedbird.

Adult male Bobolink in breeding plumage is black, neck buffy, shoulders and rump ashy white, back streaky. The female and male in fall and winter are yellowish brown, streaked above,—dull yellowish birds, resembling Sparrows in markings, but known by the acute tail feathers. Length $7\frac{1}{2}$ inches. See plate V facing page 172.

The Bobolink is found in North America from Southern New Jersey northward to Nova Scotia and westward to Utah and Northern Montana; winters in South America. In Pennsylvania the Bobolink breeds in practically all of the State with the exception of the counties of higher altitudes. This area lies north of a line which gradually curves upward from Western Fayette County to just north of Centre County then downward to the junction of Pennsylvania, Delaware and Maryland. The bird is a spring and fall migrant in most of the territory in which it does not breed.

This is a bird of the grass and grain fields especially. With us it is most welcome because of its agreeable disposition, sweet song, and insectivorous habit. The song is a rich, clear, tremulous whistle, sung in chorus.

Bobolinks generally nest shortly after their arrival in May. The nest, which is composed of grasses, is placed on the ground. The eggs number four to seven and are grayish white, frequently tinged with the color of the numerous, irregular spots and blotches of olive brown or umber. Eggs average .85 x .62 inch.

The United States Bureau of Biological Survey collected 291 Bobolinks during the months of May to September, inclusive. The stomach contents consist of 57.1% animal matter and 42.9% vegetable matter. The former includes predaceous beetles, beetles of the June-bug family, snout-beetles, and others, wasps, ants, etc; cater-

pillars, grasshoppers, other insects, spiders and myriapods (thousand-legged "worms," etc.). The vegetable food includes oats and other grain, weed seed and other vegetable seeds.

* * * "The picturesqueness of the Bobolink and the melody of its song do not offset the financial loss and harassing care of the Southern rice growers. As the case stands at present the harm done by the bird far outweighs its benefits; but it is to be hoped that science may devise some means by which the rice growers may be relieved from some portion, if not all, of the labor and expense now incident to saving their crops from its devastation." (F. E. L. Beal, Bull. 13, Bureau of Biological Survey, 1900).

It should be born in mind that Prof. Beal's remarks pertain to the status of the Bobolink in the rice-growing sections of our Southern States. In Pennsylvania the Bobolink is a beneficial bird, because insectivorous. However, it is rated as a game bird, and may be killed as such from the first of September to the first of January.

495. *Molothrus ater* (Bodd.). The Cowbird.

The head, neck and breast of the adult male cowbird are dark brown, while the rest of the plumage is black with a metallic luster. The female is dark brownish gray, paler below, especially on the breast.—Length about eight inches.

Breeds from Texas to New Brunswick and Manitoba; winters from southern Illinois southward. In Pennsylvania the Cowbird is a common summer resident, arriving late in March or early in April and remaining until the latter part of October.

Like the Cuckoo of the Old World, the Cowbird constructs no nest but deposits its eggs in the nests of other species. Over ninety species are thus known to be victims. These include principally birds smaller than the Cowbird and are represented mainly by the warblers, vireos, and sparrows. It is generally believed that but one egg is deposited by a female in each nest and that whenever two or more eggs are found, they have been deposited by as many birds. This trait of the Cowbird would not be so bad were it not for the fact that the progeny of the rightful owners of the nest seldom become old enough to fly, as the young Cowbird, because of its greater size to begin with, receives most of the food. As many as a dozen eggs are believed to be laid by one female. The eggs are white, with even and distinct brown specks; .86 x .65 inch.

Cowbirds are usually observed in small flocks and associate quite generally with cattle. It was long supposed that they do so because of the food they obtain, especially insects captured on or near the cattle, but the investigations of the U. S. Biological Survey have failed to substantiate this idea.

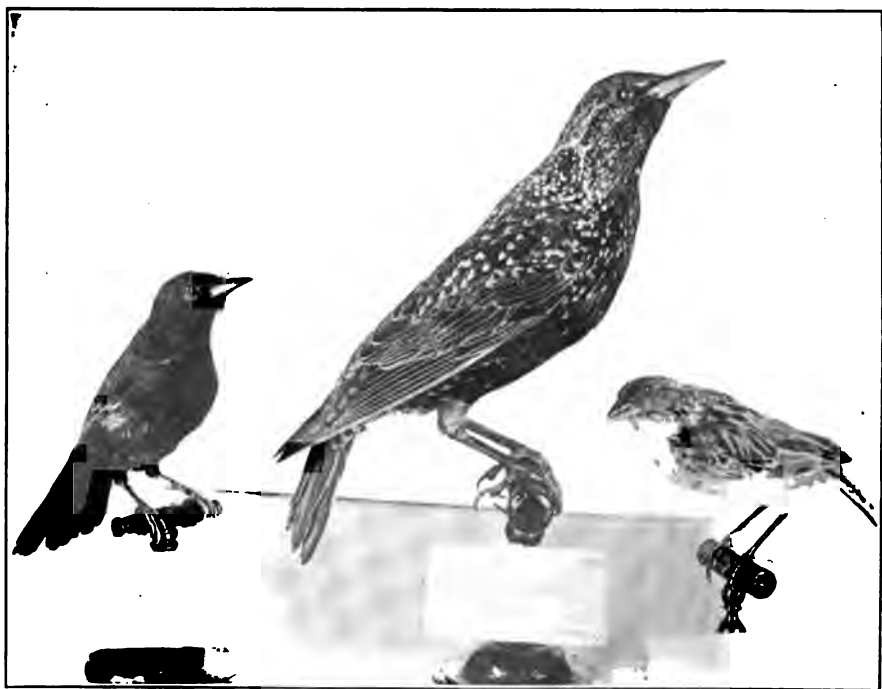
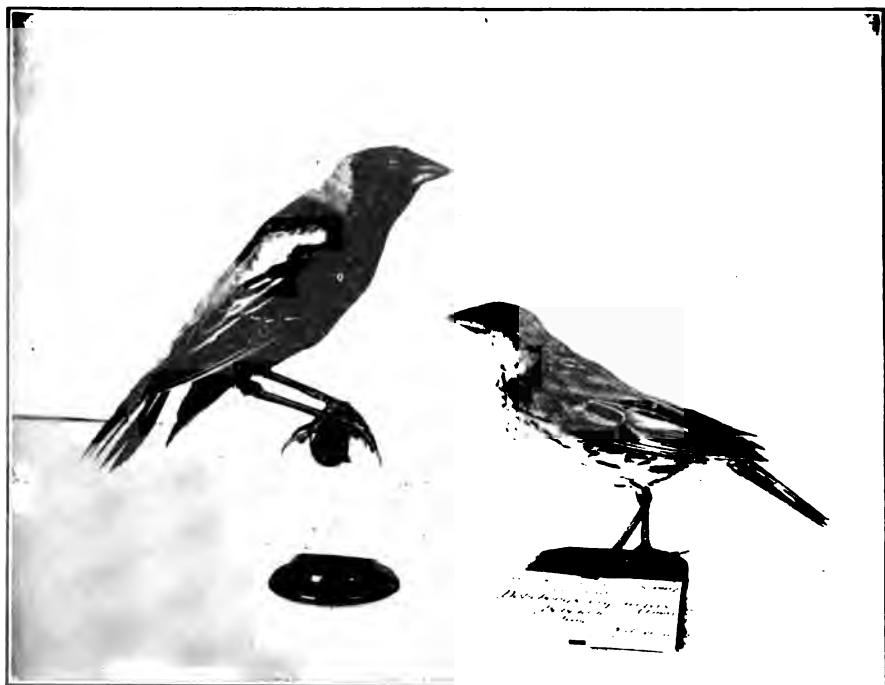


Plate V. The Male Bobolink (upper left-hand) and the female (upper right-hand). The Orchard Oriole (lower left-hand), the European Starling (middle) and the Grasshopper Sparrow (lower right-hand).

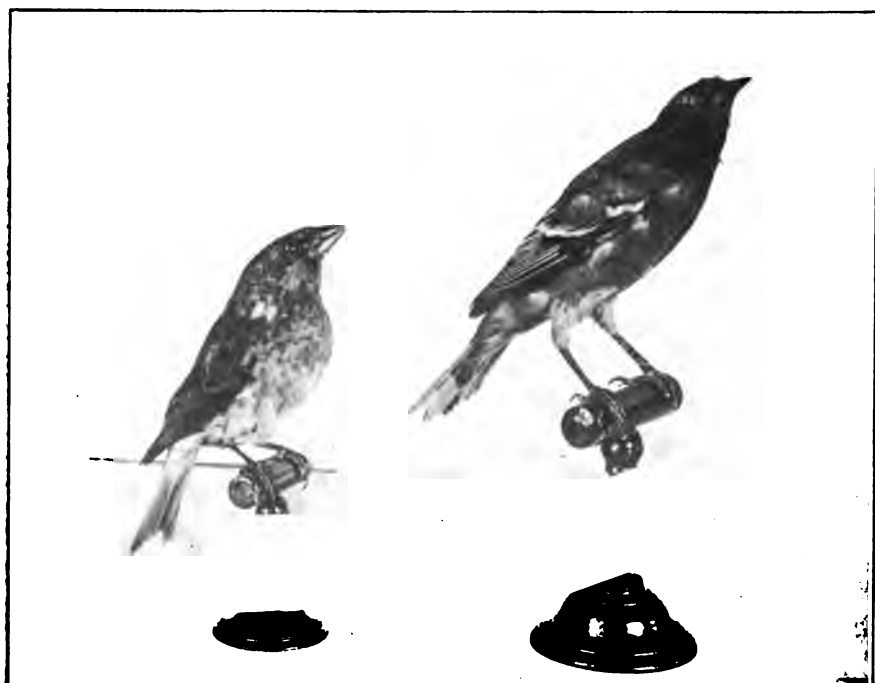


Plate VI. Male Red-wing Blackbird (upper left-hand) and the female (upper right-hand). The Purple Finch (lower left-hand) and the Baltimore Oriole (lower right-hand).

That Bureau examined 544 stomachs, taken from birds collected during ever month of the year and in twenty states and the District of Columbia and Canada. The total food found in these stomachs was: animal matter, 22.3% and vegetable, 77.7%. The animal food consists almost entirely of insects and spiders. The insects are represented by wasps, ants, bugs, a few flies, beetles, grasshoppers, and caterpillars. Grasshoppers are the favorite and form 11% of the whole diet.

The vegetable food consists mainly of weed seed (over 50% of total food) and grain (16%). Prof. Beal concludes that at least one-half of the grain is waste. The weed seeds represent many of the notoriously noxious weeds. The destruction of such seeds, together with that of the injurious and annoying insects which the Cowbird eats, surely shows the beneficial nature of this bird.

497. *Xanthocephalus xanthocephalus* (Bonap.). **The Yellow-headed Blackbird.**

The entire plumage of the Yellow-headed Blackbird is black, with the exception of the white patch on the wings and the yellow head, throat, and chest. Length ten inches.

Breeds in Western North America, ranging as far north as Manitoba and eastward to Illinois; casually observed in some of the eastern states. In Pennsylvania a rare accidental straggler from the west; one record, a young male shot near Philadelphia, August 1851 (Stone).

498. *Agelaius phoeniceus* (Linn.). **The Red-winged Blackbird.**

The male Red-winged Blackbird is glossy black, with a *scarlet wing patch on the shoulder*. The wing patch has a buffy and white edge. The female is an inconspicuous bird, the plumage generally being dusky, streaked with black and white on the underparts. Length 9½ inches. See plate VI facing page 172.

This bird is found throughout Eastern North America, from the Gulf of Mexico to New Brunswick and Manitoba during the breeding season, but winters from Virginia southward. It is found about swamps or the marshy borders of lakes, rivers, and estuaries. In the spring the males appear first, followed by the females. After the breeding season all, including the young, congregate in great flocks and frequent the grain fields.

Mating begins about the middle of May, but the nesting season is short, so flocks of old and young are seen in July. The characteristic call of the male is a rich "kong-quer-ree." The bulky nest is composed of grasses, weeds, etc., lined with finer grasses and rootlets,

and is attached to low bushes, reeds or weeds. It is generally placed near water. Eggs are three to five; pale blue, streaked, spotted, and scrawled with dark purple or black, chiefly at the larger end; 1.04 x .72 inch.

Their presence in grain fields has led many people to believe that this bird is a conspicuous grain-eater, but investigation shows that this belief is not well founded. The Biological Survey collected 1,083 birds during every month of the year, and from thirty States, the District of Columbia and Canada. The stomach contents of these birds consists of 73.4% vegetable food and 26.6% animal food. During June the animal food forms 88.2% of the total food. Insects form one-fourth of the year's food, and are represented by predaceous beetles, snout beetles, and others, caterpillars, grasshoppers, and other insects. Spiders, myriapods and other material make up the balance of the animal food. The vegetable food includes fruit, grain (13.9%), weed seed, and other material.

"In summing up the economic status of the Red-wing the principal point to attract attention is the small percentage of grain in the year's food, seemingly so much at variance with the complaints of the birds' destructive habits. Judged by the contents of its stomach alone, the Red-wing is a most decidedly useful bird. The service rendered by the destruction of noxious insects and weed seeds far outweighs the damage due to its consumption of grain. The destruction that it sometimes causes must be attributed entirely to its too great abundance in some localities." (F. E. L. Beal).

501. *Sturnella magna* (Linn.). The Meadowlark.

The Meadowlark is brownish and streaked above; chiefly yellow below, with a *black crescent on the breast*. *The white outer tail feathers show in flight*. Length 10 inches. See plate II facing page 162.

This is a very common bird throughout Eastern North America. In Pennsylvania it is found throughout the year, but in winter it occurs more commonly in the southern counties.

It is a bird of the grassy fields; consequently it is more often heard than seen. Its song is a clear, plaintive whistle, uttered as the bird stands in the grass or on some post or low limb of a tree.

The nest is placed on the ground and is made of grasses. Very frequently the nest is arched, with the entrance to one side. The eggs are four to six in number and are white, speckled with brown. Size 1.15 inches x .80 inch.

The Bureau of Biological Survey collected 228 Meadowlarks in 24 States, the District of Columbia, and Canada. The examination of the stomachs shows that insect food constitutes 71.7%; vegetable,

26.5%, and mineral, 1.8%. Excluding the mineral factor, the animal food amounts to 73% and the vegetable to 27%. During August and September practically all of the food consists of insects. On the other hand, in March few insects are active, yet 73% of the food is insects; in December 39% and in January 24%. Grasshoppers and crickets are the most important, constituting 29% of all food consumed during the year. The percentage of 1% in January increases to 69% in August. Beetles form 18%, and of these the Scarabæidæ (May and dung beetles) are the most important. Weevils are a small but constant factor. Other beetles amount to 3%, mostly leaf-beetles. Bugs, principally Pentatomidæ (stink-bugs), constitute 4%, while ants are over 3% for the year, and amount to 7% in June. Caterpillars are also important.

Of the vegetable food, grain (corn, wheat, and oats) forms 14.4% and is mostly eaten in January; hence mainly waste grain in the fields. In summer the grain item disappears. It should be noted that no sprouting grain was found in the stomachs examined. Weed seeds are eaten during every month in the year except May, and reach a maximum of 25% in December.

506. *Icterus spurius* (Linn.). The Orchard Oriole.

The male Orchard Oriole is black, with the bend of the wing and lower under parts chestnut brown, while the female is yellowish olive. Length 7 inches. See plate V facing page 172.

It is a common bird throughout the Eastern United States. In Pennsylvania it is a summer resident only.

The Orchard Oriole is a bird of open groves and orchards. The nesting season is in May and June and the nest, which is purse-shaped and composed of grasses, is usually placed from eight to twenty feet from the ground, more often about ten feet. The eggs number three to five; are bluish white, distinctly and obscurely spotted, blotched, and scrawled with fuscous or black, and average .79 x .58 inch. The clear, distinct song is uttered with much expression.

"Few birds do more good and less harm than our Orchard Oriole, especially to the fruit grower. The bulk of its food consists of small beetles, plant lice, flies, hairless caterpillars, cabbage worms, grasshoppers, rose-bugs, and larvæ of all kinds; while the few berries it may help itself to during the short time they last are many times paid for by the great number of noxious insects destroyed, and it certainly deserves the fullest protection." (Bendire). "Locust leaf-mining beetles are also in the Orioles' list, and it is interesting to note that in a case when it had a choice between cherries and mulberries, it took mulberries." (Florence Merriam Bailey).

507. *Icterus galbula* (Linn.). The Baltimore Oriole, Fire Bird,
Golden Robin, Hangnest.

The Baltimore Oriole is black, with the bend of the wing, rump, most of the tail feathers, and under parts orange of varying intensity. The female is duller, the prevailing colors being olivaceous and yellow. Length $7\frac{1}{2}$ inches. See plate VI facing page 172.

It is an abundant summer resident in Pennsylvania and winters in Central America. Like its near relative the Orchard Oriole, it loves to dwell in trees in open areas, but prefers shade trees to fruit trees. The song is a melancholy, but sweet, clear whistle.

Perhaps but few persons are ignorant of the fine, pendulous nest often seen hanging from the long, drooping twigs of such trees as the elm. This fine basket is constructed by the female and is an example of excellent architecture. Sometimes these nests are built almost entirely of twine. The Orioles begin to nest about the 25th of May. The eggs are four to six in number; are white, scrawled with fine, distinct or obscure black or fuscous lines, and a few spots or blotches, and average .94 x .63 inch.

In the Yearbook of the United States Department of Agriculture for 1895 there is given a report on the food of the Baltimore Oriole. One hundred and thirteen specimens were collected in twelve States, the District of Columbia, and Canada, during the months from April to August inclusive and in November. The animal food constitutes 83.4% and the vegetable food 16.6%. Excluding November, most of the insects are taken in May (92%) and the least in April and July (70%). In November stomachs, insects form 98% of the food. Caterpillars constitute 34%. Beetles stand next in importance. Elateridæ or click-beetles (the adults of wire-worms) amount to 9% for the months of May, June, and July. May beetles constitutes $3\frac{1}{2}$ %. Some Chrysomelidæ or leaf-beetles, especially *Diabrotica vittata*, the "striped cucumber beetle," are eaten. Wasps aggregate 11% and bugs 6%. In May flies amount to 4% and in November to 7%. Grasshoppers and crickets are taken. Spiders form 6% for the season.

In the vegetable food are found fruit, grain and weed seed. Prominent among the fruit are cherries, raspberries, blackberries, huckleberries, elderberries, and Juneberries.

509. *Euphagus carolinensis* (Müll.). The Rusty Blackbird.

The male Rusty Blackbird is glossy black, which becomes rusty in autumn. The female is dusky and lacks the luster of the male. Length $9\frac{1}{2}$ inches.

This bird breeds from New Brunswick and Manitoba northward to Labrador and Alaska, and winters from Virginia southward. It will be seen, therefore, that this bird occurs in Pennsylvania as a transient. In this State it is a rather common spring and fall migrant.

While with us the Rusty Blackbird is much like the Red-Wing, as it prefers swampy localities. It resembles the Grackle somewhat, but is a quiet, unassuming bird.

The Biological Survey collected 132 Rusty Blackbirds from sixteen States, the District of Columbia, and Canada, in every month of the year except June and July. Animal food is preferred by these birds, and vegetable food is only a makeshift. The former amounts to 53% and the latter to 47% of the total food. The animal food consists of predaceous beetles, beetles of the family Scarabæidæ (June Bugs, etc.), and other beetles, caterpillars, grasshoppers, and other insects, spiders, myriapods (thousand-legged "worms"), and other animal food. The vegetable diet includes corn and other grain, weed seed and other vegetable food. Inasmuch as the Rusty Blackbird is a transient in Pennsylvania, and lingers with us but a short while, its relation to human interests is not of so much consequence as in regions where it makes its summer and winter home.

511. *Quiscalus quiscula* (Linn.).
Blackbird.

The Purple Grackle or Crow

The Purple Grackle is of an iridescent black color, with a purplish luster on the head. Length 13 inches.

This bird is found in Pennsylvania east of the Alleghenies as a summer resident. West of these mountains it is a spring and fall migrant only.

In the spring the Bluebirds and Robins are soon followed by the Grackles. They are then welcome birds because they are quite confident and walk sedately about the dooryard or follow the plow. They are sociable birds among themselves, and are found in colonies or flocks throughout the year.

The nest is made of grasses, frequently cemented together with mud. It may be built in almost any tree, provided the foliage is sufficiently dense, but preference is given to coniferous trees. Sometimes the nest is placed in a dense bush. The eggs number three to six; are pale blue or green, spotted, blotched and scrawled with umber, black or cinnamon brown, and average 1.15 inches x .82 inch.

Nearly 2,500 Blackbirds were collected by the Biological Survey in twenty-seven States, the District of Columbia, and Canada and

during every month in the year. Few were taken in November to February inclusive, while over one-half were collected in May and June. During these two months 456 nestlings were collected. Food was found in 2,346 stomachs. Of the food 30.3% is animal and 69.7% vegetable. The former includes insects, spiders, myriapods, crayfish, earthworms, sowbugs, "hair-snakes," snails, fish, tree toads, salamanders, lizards, snakes, birds eggs, and mice.

Insect food forms 27% of all for the year. In May more than one-fifth of all food consists of insects of the May beetle family, and in June one-seventh of all food is white grubs or June bugs (picked up by following the plow). Curculios occur every month and in great numbers, being found in 1,059 of the stomachs examined. Grasshoppers are eaten every month but January, and reach a maximum in August when they constitute 23.4% of all food. Caterpillars are eaten during every month but November, judging from the examination of the stomachs.

The vegetable food includes grain (corn, 37.2%; oats, 2.9%; wheat, 4.8%, and other grains such as rye and buckwheat, 1.6%); cultivated fruit, 2.9% (blackberries, raspberries, cherries, currants, grapes, and apples); wild fruit, 2.1%; weed seed, 4.2%; mast, etc., 14.0%. The grain is chiefly waste, as none appeared to be eaten at seed or sprouting time.

In the nestling Grackles the animal food amounts to 74.4% and the vegetable to 25.6%, showing a great increase in the proportion of insects fed to the young.

511b. *Quiscalus quiscula aeneus* (Ridgway). The Bronzed Grackle.

The Bronzed Grackle differs from the Purple Grackle in colorations. Head, neck, throat and upper breast all around varying from brilliant metallic purple to bluish green or steel-blue; *back metallic* bronze, feathers without iridescent bars; wings and tail metallic purplish or bluish black; brown breast and belly similar to the back but duller. See plate IV facing page 166.

Breeds from Texas to Great Slave Lake, east to the Alleghanies, as far north as Pennsylvania, and north of this eastward to Connecticut and northward to Labrador. It winters in the lower Mississippi Valley. In the western half of Pennsylvania the Bronzed Grackle is an abundant summer resident, and occurs mainly in migrations in the eastern half.

The nest, eggs, and habits of this species are similar to those of the Purple Grackle.

FAMILY 28. FRINGILLIDÆ. The Finches, Sparrows, Etc.

The family Fringillidæ includes the birds known as Finches, Sparrows, Linnets, Grosbeaks, Crossbills and Buntings. Although they appear to show considerable diversity they all agree in having nine primaries, the first being obsolete; the bill stout and conical, with the corners of the mouth drawn downward, and other fundamental structures.

It is our largest family of birds, and includes about 100 genera and 550 species. This family is represented in all parts of the world except the Australian region. About one-seventh of the species are found in North America, while thirty-three species occur in Pennsylvania. These birds are mainly seed eaters, and are especially valuable in keeping down weed seeds. They are more or less migratory, but as a rule do not fly great distances. Most of our species are dull-colored birds of the ground, while some, such as the Indigo Bunting and Cardinal are brightly colored species, and rather birds of bushes or trees. The family contains many good songsters, some of which are favorite cage birds, such as the Bullfinch and Chaffinch in England, and the Cardinal in this country; while the Canary is undoubtedly our best known cage bird.

The thirty-three species that occur in Pennsylvania may be divided, according to their occurrence, into the following: permanent residents, summer residents, winter residents, winter stragglers or visitors, spring and fall transients, and rare stragglers.

The permanent residents include the introduced House or English Sparrow, the American Goldfinch, Song Sparrow, Cardinal, Junco, and Swamp Sparrow. The Junco, or Slate-colored Snow-bird, is a permanent resident only in the higher parts of the Allegheny Mountains, and has been observed nesting in Sullivan, Wyoming, Luzerne, and Centre Counties, while the Swamp Sparrow is locally distributed during the breeding season in Southern Pennsylvania.

The summer residents are the Vesper, Grasshopper, Henslow's, Sharp-tailed, Lark, Chipping and Field Sparrows, Towhee, Rose-breasted Grosbeak, and Indigo Bunting. Henslow's and the Sharp-tailed Sparrows are rare or accidental in Southeastern Pennsylvania, while the Lark Sparrow is recorded as a very rare summer resident in the western part of the State. The Rose-breasted Grosbeak is not found south of Monroe and Schuylkill counties as a summer resident in Eastern Pennsylvania. In the western part of the State it is rather common.

The winter residents are the Purple Finch, Tree Sparrow, White-throated Sparrow, Fox Sparrow, Junco, American and White-winged Crossbills, Redpoll and Pine Siskin. The Fox Sparrow is recorded as

wintering in the vicinity of Philadelphia. The Crossbills and Redpoll are very irregular, being almost entirely absent some years, while during very severe and prolonged winters they may be quite common. Such was the case during the winter of 1908-09, when birds of these species were quite common in some localities.

Very rare winter stragglers or visitors are the Evening Grosbeak, Pine Grosbeak, Snow Bunting, and Lapland Longspur.

The spring and fall transients are the Savanna, White-throated, White-crowned, Lincoln's, Swamp, and Fox Sparrows, and the Rose-breasted Grosbeak. The Swamp Sparrow is recorded from the vicinity of Philadelphia. Lincoln's Sparrow is rare. In eastern Pennsylvania the Rose-breasted Grosbeak is not very common as a transient species.

The rare stragglers include the Blue Grosbeak and the Dickcissel. The Blue Grosbeak wanders from the southern States and is said to have bred in Cumberland County (Baird) and in Lancaster County (Libhart). About one-half a century ago the Dickcissel is said to have been fairly common in the middle Atlantic States.

KEY TO THE PENNSYLVANIA SPECIES OF FRINGILLIDÆ.

- I. Breast with more or less *yellow*.
 1. Breast and under parts pure yellow, crown and wings black. 529. *American Goldfinch*, page 188.
 2. Chin white, throat black. 604. *Dickcissel*, page 206.
 3. Belly and forehead yellow, crown black, wings and tail black. 514. *Evening Grosbeak*, page 183.
- II. Breast *blue*.
 1. Plumage *deep blue*, a *chestnut bar* across the wings, length 7 inches. 597. *Blue Grosbeak*, page 205.
 2. Plumage *indigo blue*, length 6 inches. 598. *Indigo Bunting*, page 205.
- III. Breast or throat *red* or *pink*.
 1. Mandibles crossed.
 - A. Body dull red, brighter on rump, and brown on back; wings and tail fuscous. 521 *Am. Crossbill*, page 186.
 - B. Body dull pink, brighter on rump, more or less marked with black on back; belly whitish; wings and tail black; greater and middle wings coverts tipped with white. 522. *White-winged Crossbill*, page 187.

2. Mandibles not crossed.

- A. Breast rose-red; belly, tip of tail, rump and a band on the wings white; rest of plumage black. 595. *Rose-breasted Grosbeak*, page 204.
- B. Throat and region about base of bill black; rest of plumage bright vermilion red; head with a conspicuous crest. 593. *Cardinal*, page 203.
- C. Plumage more or less heavily marked with dull reddish, more intense on crown; everywhere streaked. 517. *Purple Finch*, page 184.
- D. Crown cap bright red; rump tinged with pink, breast suffused with pink, belly white, sides streaked with fuscous; back grayish brown, feathers margined with buffy. 528. *Redpoll*, page 187.
- E. Slaty gray, more or less washed with rose-red, strongest on crown, rump, upper tail-coverts and breast; wings fuscous, their coverts edged with white; tail fuscous. 515. *Pine Grosbeak*, page 184.

IV. Breast *neither* yellow, blue nor red.

1. Under parts distinctly streaked or spotted.

- A. Outer tail feathers with white patches.
 - a. Hind toe-nail shorter than bill from nostril; the lesser wing coverts rufous; breast streaked with black. 540. *Vesper Sparrow*, page 190.
 - b. Hind toe-nail longer than bill from nostril; under parts whitish, breast streaked or spotted with black or entirely black. 536. *Lapland Longspur*, page 190.
- B. Outer tail feathers not white.
 - a. Under parts white tinged with buffy and heavily streaked with black. 533. *Pine Siskin*, page 189.
 - b. Under parts white, sides washed with brownish and streaked with black and rufous brown; breast with wedge-shaped streaks of black and rufous brown, which tend to form one large blotch on the center. 581. *Song Sparrow*, page 199.
 - c. Under parts white, rather finely streaked with black, a broad cream-buff band across the breast. 583. *Lincoln's Sparrow*, page 200.

- d. Under parts white, with large arrow-shaped spots and streaks; ashy above, much streaked and covered with red; tail bright bay. 585. *For Sparrow*, page 201.
 - e. Breast and sides washed with buffy and distinctly streaked with black; middle of throat and belly white or whitish; tail-feathers narrow and sharply pointed; bright buff stripe over eye; chin ashy, back streaked; bird of salt marshes. 549. *Sharp-tailed Sparrow*, page 193.
 - f. No buffy on sides of head or breast; under parts white, heavily streaked with blackish and rufous, the breast-feathers tipped with wedge-shaped marks; upper parts blackish; bird of salt and fresh water marshes. 542a. *Savanna Sparrow*, page 191.
 - g. Under parts white, more or less washed with buffy and streaked with black on the breast and sides; back reddish; head and neck buffy olive; bird of wet pastures generally. 547. *Henslow's Sparrow*, page 193.
 - h. Under parts grayish white on belly, flanks cream buff; throat like breast but paler; streaked above; white streak above eye; center of crown with a white streak, bordered on either side by black. 554. *White-crowned Sparrow*, page 194.
2. Under parts not distinctly streaked or spotted.
- A Under parts white, tinged with buffy on breast and sides.
 - a. Bend of wing yellow; tail even, and pointed; last half of outer tail feathers gray. 546. *Grasshopper Sparrow*, page 192.
 - b. Top of head rufous, back also rufous but finely streaked; bill reddish-brown. 563. *Field Sparrow*, page 197.
 - B. Under parts white, breast and sides washed with rusty; upper parts rusty brown, back streaked with black, outer tail feathers white, and inner black. 534. *Snow Bunting*, page 189.

- C. Under parts grayish white or ashy white.
 - a. Crown brown.
 - a'. Crown rufous brown and sides tinged with pale grayish brown; indistinct black spot on center of breast; white wing bars distinct. 559. *Tree Sparrow*, page 196.
 - b'. Crown chestnut, forehead black, rump gray, and bill black; back streaked; wing bars not distinct. 560. *Chipping Sparrow*, page 196.
 - b. Crown black with a white median stripe and white stripe over each eye; edge of wing always yellow; ashy below; white patch on throat. 558. *White-throated Sparrow*, page 195.
- D. Under parts white, small black spot in middle of breast; sides of crown and ear-coverts chestnut; whitish line over eye, and through center of crown. 552. *Lark Sparrow*, page 194.
- E. Throat and breast slate-color like back; belly and outer tail feathers white; bill flesh color. 567. *Junco*, page 198.
- F. Under parts white or whitish; back brown, streaked with black; cap and wings chestnut. 584. *Swamp Sparrow*, page 201.
- G. Throat and breast black.
 - a. Sides of throat and belly white, crown ash, sides of head chestnut. *House Sparrow*, page 185.
 - b. Sides of body light rufous, outer tail feathers tipped with white. 587. *Towhee*, page 202.

514. *Coccythraustes vespertinus* (Coop.). The Evening Grosbeak.

The male Evening Grosbeak is olivaceous; crown, wings, tail, and tibia, black; forehead, rump, and crissum yellow; inner secondaries and coverts white; bill very large and yellowish. Female gray, with little yellow. Length eight inches.

Breeds in the interior of North America from Manitoba northward. Migrates southward in winter to the Upper Mississippi Valley and casually to the Northern Atlantic States. "This species is very erratic in its winter wanderings, and in the season of 1889-90 appeared in abundance very far east of its usual range—Columbia. Lackawanna, and Lycoming Counties, Pa." (Stone).

Nest composed of small twigs, lined with bark, hair or rootlets, placed within twenty feet of the ground. Eggs three to four; greenish, blotched with pale brown.

Since the Evening Grosbeak is of rare occurrence in Pennsylvania it is of little economic importance.

515. *Pinicola enucleator* (Linn.). The Pine Grosbeak.

The Pine Grosbeak is "slaty gray, more or less washed with rose-red, strongest on the crown, rump, upper tail coverts and breast; wings fuscous, their coverts edged with white; tail fuscous." Length about 9 inches.

The Grosbeak is found in the "northern parts of the northern hemisphere, breeding far north; in winter south in North America, irregularly to the Northern United States." Rare and irregular visitant in Pennsylvania in the depth of winter. "A flock seen at Wynnewood, Montgomery County, Pa., by Mr. Wm. L. Bailly, Jan. 15, 1882 and several specimens were secured." (Stone).

The nest is composed of twigs and rootlets, lined with finer materials, in coniferous trees a few feet up. Eggs pale greenish blue, spotted and blotched with dark brown surface markings and lilac shell spots; average size 1.05 inches x .74 inch.

The food consists of the berries of the mountain ash and sumac bushes here in winter, but very little is known of the food where the Pine Grosbeak makes its summer home. Very little economic importance in Pennsylvania.

517. *Carpodacus purpureus* (Gmel.). The Purple Finch.

The male Purple Finch is distinctly marked because of the streaked plumage which is suffused with red, most decided on the crown, breast, and rump; tail fuscous. Female olive brown presenting the same streaked appearance as the male but no red is present. It will be seen that the word "purple" is misapplied, and the more correct name of Rose Finch has, therefore, been suggested. Length six inches. See plate VI facing page 172.

This Finch is a summer resident in North America from Northern Minnesota and Long Island northward, but with us is a spring and fall transient and in some localities occurs as a winter visitant also. During its sojourn the Purple Finch is found about orchard and shade trees and in gardens. It is an excellent songster, whose song is sweet, clear and uttered with freedom and ease.

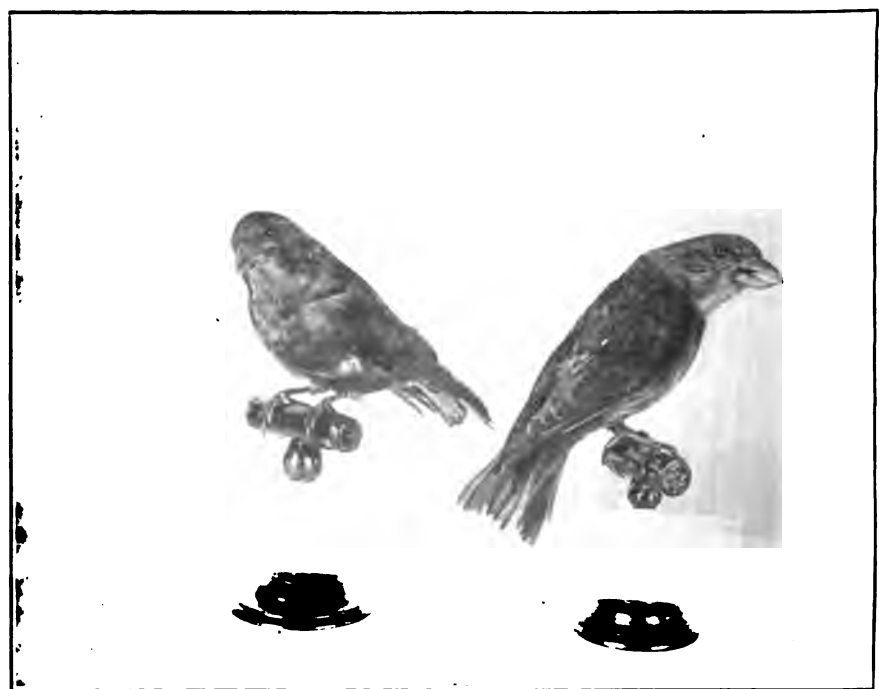
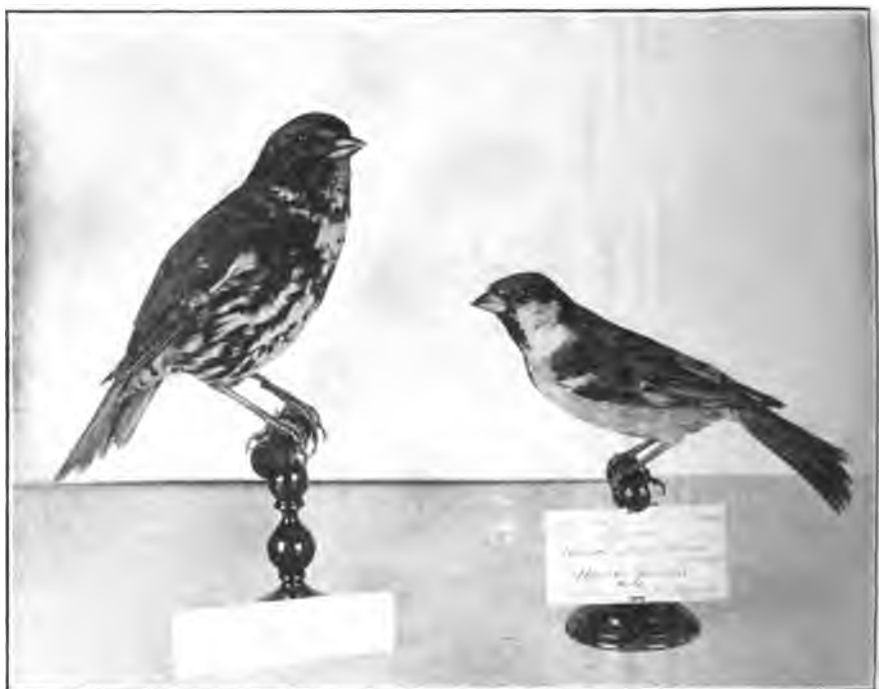


Plate VII. The Fox Sparrow (upper left-hand) and the male House Sparrow (upper right-hand). Male American Crossbill (lower left-hand) and the female (lower right-hand).

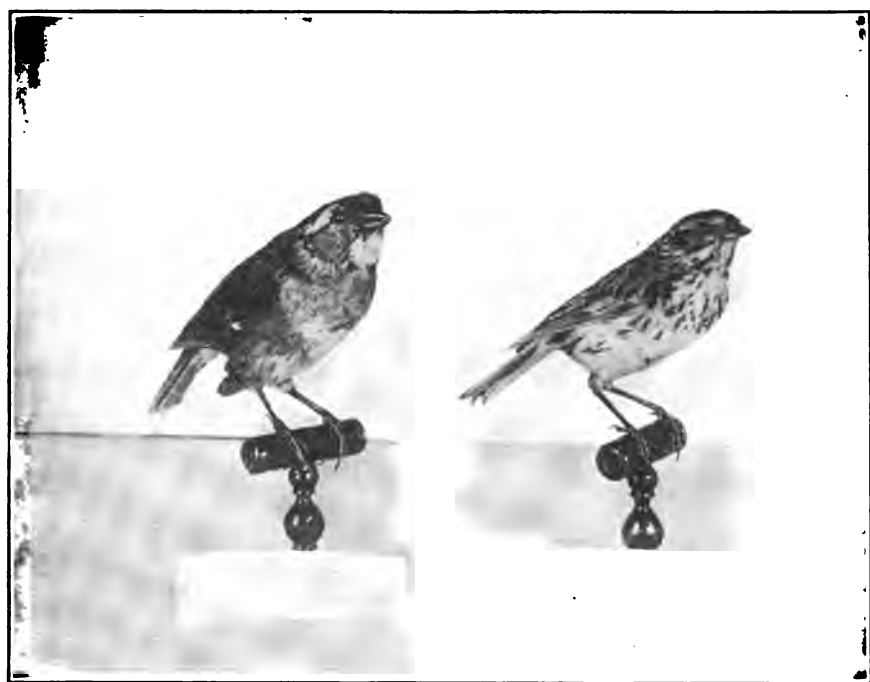
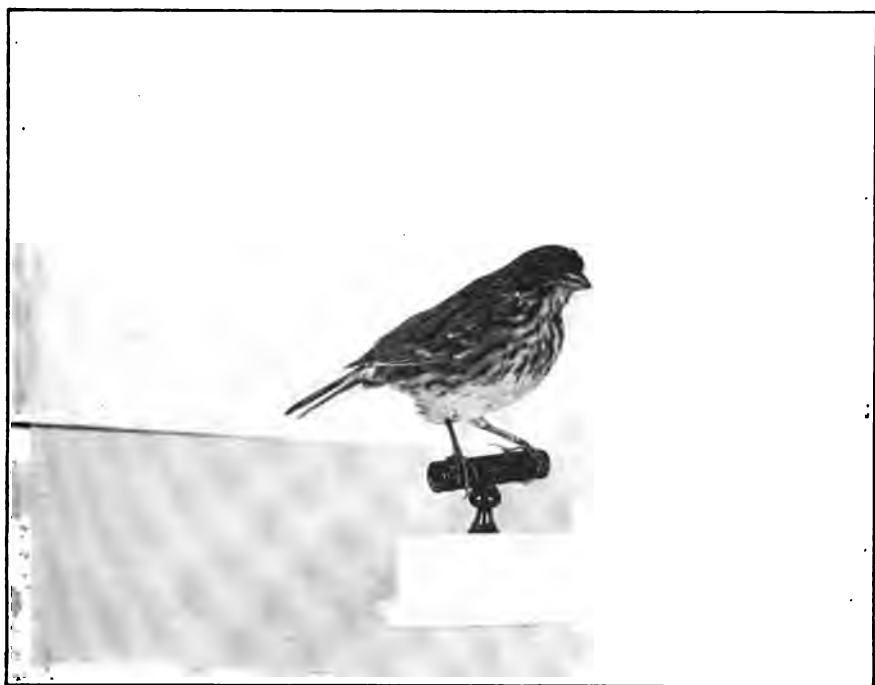
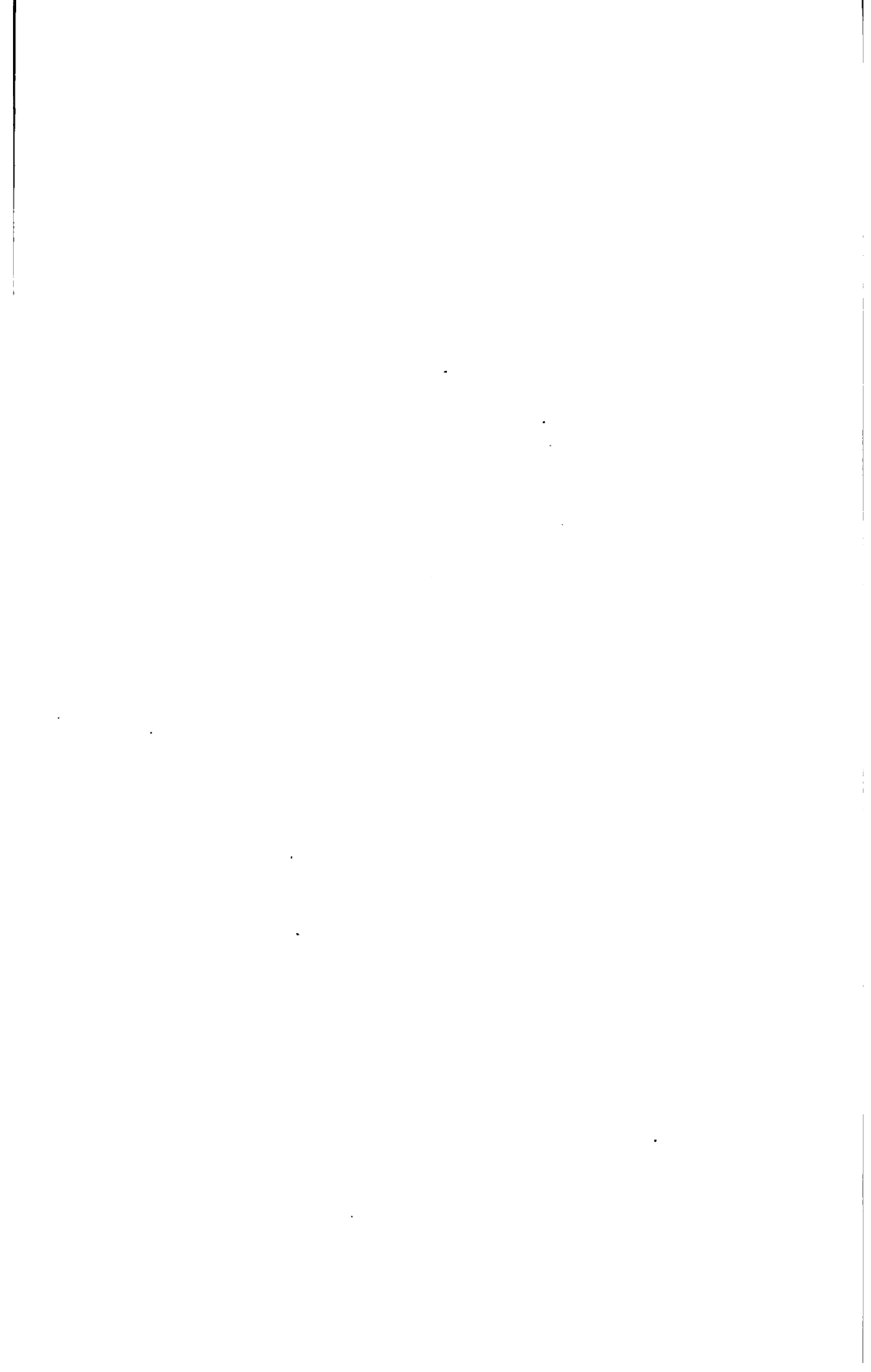


Plate VIII. The Vesper Sparrow (upper figure), the White Throated Sparrow (lower left-hand) and the Savanna Sparrow (lower right-hand).



Nest composed of twigs, grasses, and rootlets, thickly lined with long hairs, in coniferous trees, five to thirty feet up. Eggs four to six; blue, spotted about the larger end with fuscous, and average .79 x .56 inch.

"Feeds on buds and blossoms of apple, cherry, peach and plum (stamens and pistils); blossoms of red maple, seeds of white ash, berries of red cedar, mountain ash and other trees; seeds of weeds, particularly rag-weed; orchard and woodland caterpillars; destructive to plant lice and cankerworms, ground beetles and few cutworms." (Folsom).

Passer domesticus (Linn.). The House or English Sparrow.

The bird under discussion is almost everywhere in this country called the English Sparrow, but the misnomer is evident when it is learned that this bird is by no means confined to England, but is quite generally distributed throughout Europe and Asia. A more appropriate name would be "House Sparrow."

Male chestnut brown above, thickly streaked; ashy below; throat, lores and chin black. Female duller and without the black. See plate VII facing page 186.

The House Sparrow was introduced into this country at Brooklyn in 1851 and 1852. Until 1870 it was confined to the Eastern United States, but it has so spread as to be found in most of the United States and Canada east of the Great Plains, and isolated colonies are established throughout the West.

The Biological Survey has made a very detailed study of the food of this bird and examined eighty-two stomachs of adults and fifty stomachs of nestlings. These birds were collected in seven States. The animal matter, practically all insects, amounts to but 2% of the food, while vegetable matter (almost all seeds) amounts to 98% of the food. Insects were eaten mainly in May and June when they formed 10 and 8% of the food for the respective months. Of the seeds 7% are those of grasses and 17% of various weeds other than grasses. Grain amounts to 74% and forms 90% of the food from June to August.

In the case of the young, 35% of the food is vegetable, 2% is weed seed and 33% grain. The animal food (65%) is all insects, and these are chiefly injurious species.

The English Sparrow is such an obnoxious bird that persons frequently seek methods for destroying them. There are now on the market several makes of large wire traps which have proven very efficient. However, poisoning Sparrows at such times as other birds are absent is a satisfactory method.

A very simple way to prepare poisoned food is as follows: Dissolve one-sixteenth of an ounce of the sulphate of strychnine in a quart of hot water. Put two quarts of wheat in deep vessels such as Mason jars and pour in the cooled strychnine solution. Allow to soak for forty-eight hours and then spread out to dry.

From Farmer's Bulletin 383 issued by the U. S. Department of Agriculture, Washington, D. C., we quote:

"A poison mixture that has proved very effective is prepared as follows: Put one-eighth ounce of strychnia sulphate into three-fourths of a gill of hot water and boil until dissolved. Moisten 1½ teaspoonfuls of starch with a few drops of cold water, add it to the poison solution, and heat till the starch thickens. Pour the hot poisoned starch solution over one quart of wheat and stir until every kernel is coated. Small-kerneled wheat sold as poultry food, if reasonably clean, is preferable to first quality grain, being cheaper and more easily eaten by the sparrows. A 2-quart glass fruit jar is a good vessel to mix in, as it is easily shaken and allows the condition of the contents to be seen. If the coated wheat be spread thinly on a hard, flat surface, it will be dry enough for use in a short time. It should be dried thoroughly if it is to be put into jars and kept for future use. Dishes employed in preparing poison may be safely cleansed by washing."

The poisoning will be most successful if done when snow covers the ground. Sweep away the snow from a square yard or more of space on the ground, a roof, or the like and, early in the morning, scatter *unpoisoned* wheat there for several days. When the Sparrows have established a feeding ground, as it were, scatter the poisoned grain. Every few hours visit the site and remove the dead birds so as not to arouse the suspicion of the others.

In poisoning English Sparrows, one should take due precautions, of course, to avoid poisoning chickens, or other unintended victims. Little anxiety need be felt for cats or dogs that might eat the poisoned birds as the latter are not sufficiently poisoned.

521. *Loxia curvirostra minor* (Brehm). The American Crossbill or Red Crossbill.

As the name indicates, the Crossbills are readily recognized by the fact that the tips of the mandibles are crossed. The prevailing color of the male American Crossbill is brick red, with *wings dusky*. Female brownish, washed with greenish yellow. Length six inches. See plate VII facing page 186.

This species breeds from the Northern States northward and in the Alleghanies southward to the Carolinas. In winter it wanders irregularly southward, sometimes to the Gulf States.

Coniferous trees are their favorites, and wherever they exist these Crossbills are most likely to be found. The crossed mandibles enable the bird to twist off the scales of the pine cones and to secure the seeds which lie at the base of the scales. Crossbills are very erratic birds, so that whenever they occur in this State it is as by sudden appearance, and as suddenly do they disappear. They move so quietly over the trees as to be passed by unnoticed. Chapman quotes: "Their song is described as varied and pleasing, but not powerful nor in any respect remarkable."

Nest composed of twigs and grasses, lined with bits of moss and rootlets, placed in coniferous trees, generally about fifteen to thirty feet from the ground. Eggs from three to four; pale greenish, spotted, and dotted about the larger end with various shades of brown and lavender shell markings. The average size is .75 inch x .57 inch.

522. *Loxia leucoptera* Gmel. The White-winged Crossbill.

The White-winged Crossbill is distinguished from the preceding by the brighter coloration of rose-red, and by the presence of *two white wing bars*. Like the preceding the mandibles are crossed. Female brownish olive, speckled with dusky, rump yellow. Length 6½ inches.

This species breeds in northern North America and moves southward in winter, as does the preceding, but is less common.

Nest of twigs and strips of birch bark, covered externally with moss and lined with soft moss and hair, placed in the fork of an evergreen in the deep forest. Eggs generally three in number; pale blue, spotted and streaked near the larger end with reddish brown and lilac; .80 x .55 inch.

On account of their habits the Crossbills are of little or no interest to the farmer, and may be considered neutral as they feed largely on the seeds of conifers.

528. *Acanthis linaria* (Linn.). The Redpoll.

Throat, breast and rump of the male Redpoll *rosy*, back grayish brown, feathers margined with buff; wings and tail fuscous, belly white, sides streaked with fuscous. Length 5.32 inches.

The summer home is in the northern parts of the northern hemisphere. In winter the Redpolls move irregularly southward in America to Illinois and Virginia. During the winter of 1908-09 these birds were found in great flocks in some portions of Pennsylvania in company with the Pine Siskins.

This little bird is called the Redpoll because the crown is rose-red. In its movements and habits while with us it is much like the Goldfinch.

Nest of dry grass and moss, lined with hair, feathers, and plant down, placed in low bushes or in a tuft of grass. Eggs number four to six; white, tinged with green or blue; spotted with reddish brown. Size .65 x .50 inch.

"Flocks of several hundred feeding in a field grown up with rag-weed, one of the worst pests" (Oberholser). "While with us it finds its wants supplied chiefly by the various grasses and herbs which project through the snow and still retain their seeds in spite of wind and weather." (Ernest E. Thompson).

529. *Astragalinus tristis* (Linn.). The American Goldfinch, Yellow-bird, Thistle-bird, Lettuce-bird, Wild Canary.

The prevailing color of the male Goldfinch is rich yellow, the rump whitish, wing bars white, white spot on each tail feather; *cap of crown black, wings and tail black*. Female more olivaceous. Fall and winter plumage of male similar to plumage of female except the wings and tail are black, former with white wing bars. Length five inches. See plate X facing page 196.

The Goldfinch is distributed over Eastern North America, breeds from South Carolina to Southern Labrador, and winters from the Northern United States to the Gulf. In Pennsylvania it is an abundant species, being found throughout the State as a permanent resident. It is commonly observed about sunflowers, lettuce and thistles, when in seed, and easily recognized by its undulating flight.

Nest is composed externally of grasses, strips of moss and bark, thickly lined with thistle down, placed in forks of trees or bushes from five to thirty feet from the ground in June or July. Eggs three to six in number; pale bluish white. They average .65 x .48 inch. As the nest-building and egg-laying generally are not completed before the end of the third week of June, these are our last birds to begin incubation.

Their food is "Weed seeds, especially downy ones like dandelion and thistle; wild cherries, wild sunflower, and rag weed seeds are favorites. Feed young largely on plant lice, caterpillars, small grass-

hoppers, and beetles, cankerworms, Hessian fly. In winter largely on eggs of plant lice; seeds of birches, button-bush, and weed seeds." (Folsom). We have observed them especially fond of seeds of cultivated lettuce and salsify or vegetable oyster. Therefore, to permit superfluous plants of these species to go to seed around the premises will do no harm, and will contribute to retaining the little "Wild Canaries" in numbers.

533. *Spinus pinus* (Wils.). The Pine Siskin, Pine Finch.

The plumage of the Pine Siskin is streaky brown, suffused with yellow in the breeding season; wings fuscous, most of the feathers margined with yellow, and yellow at the base; tail fuscous, all but the middle feathers yellow at the base; under parts white, tinged with buffy and heavily streaked with black. Length five inches.

Found in North America generally, but breeds mostly north of the United States; winters as far south as the Gulf of Mexico. In Pennsylvania it is an erratic and irregular winter visitant.

Nest composed of twigs and rootlets, lined with plant down and long hair, placed in coniferous trees. Eggs usually four in number; pale bluish white, thickly spotted with reddish brown; .67 x .46 inch.

Pine Siskins are known to feed extensively on weed seeds and the seeds of evergreens during their sojourn here.

534. *Passerina nivalis* (Linn.). The Snow Bunting or Snowflake.

During the breeding season the Snow Bunting is pure white with the exception of black on the back, wings, and tail; bill and feet black. In winter the bill is pale and the white of the body is clouded with clear brown. Length 7 inches.

Breeds in the Arctic regions and moves southward in winter to Northern United States, but sometimes to Southern Illinois, Kansas, and Georgia. A very rare winter straggler in Pennsylvania.

A bird of the open, wind-swept areas, over which it *walks* much like the Horned Larks. Unlike many other sparrows it does not require close proximity to shelter of trees and shrubs, but visits knolls exposed and denuded of snow by the wind. Snowflakes are generally found in great flocks.

Nest of grasses, rootlets, and moss, lined with finer grasses and feathers, on the ground. Eggs two to seven; pale bluish white, thinly marked with umber or heavily spotted or washed with rufous brown. They average .85 x .64 inch.

While here the Snow Buntings derive half their sustenance from the seeds of two weeds,—amaranth (includes such plants as pigweed and tumbleweed) and ragweed. Only one per cent. is grass seed. As many as 500 to 1,500 amaranth seeds were found in one stomach according to the report of the Biological Survey.

536. *Calcarius lapponicus* (Linn.). The Lapland Longspur.

The head and throat of the male Lapland Longspur in summer are mostly black; the collar chestnut, back black and streaky; whitish below; outer tail feathers with white; inner web of outer feather dusky; legs and feet black. The female and winter birds have less black. The hind toe-nail is as long as the toe or longer. Length 6½ inches.

The Lapland Longspur breeds in the northern regions, but moves southward in winter to the Northern United States, irregularly to the Middle Atlantic States, and accidentally to South Carolina. It is a very rare winter straggler in Pennsylvania.

Like the Snowflakes, the Longspurs remain well northward and generally move in fall and spring with these birds. They are strictly terrestrial, and, almost without exception, are gregarious. Sometimes they occur with Horned Larks. They often hide by squatting behind sods.

Nest composed of grasses and moss, lined with finer grasses, placed on the ground. Eggs four to six; bluish white, almost obscured by a uniform grayish brown; .82 x .60 inch.

The Biological Survey collected 113 Longspurs from December to May, inclusive, in Wisconsin, Illinois, Minnesota, Iowa, Kansas, and Texas. The animal food, which amounts to 6% of the total food, is composed entirely of insects. The vegetable food forms the remaining 94%, and is composed of grain and weed seed. Three-fourths of all, or 70.5%, consists of grain and grass. The former amounts to 27%, of which millet (19%) is prominent. (Most of the specimens were collected in millet-growing regions). Practically all the grain, however, is waste or is picked up from the stubble. The weed seeds include those from ragweed, sorrel, amaranth, lamb's quarter, purslane, sedge, etc.

540. *Poocætes gramineus* (Gmel.). The Vesper Sparrow, Bay-winged Bunting, or Grass Finch.

The Vesper Sparrow is one of our obscurely marked birds. The upper parts are brownish gray, streaked with black and a little

ochraceous buff; wings fuscous; greater and middle wing coverts tipped with white, lesser coverts bright fuscous; tail fuscous, *the outer feather mostly white*, the next one with much less white; under parts white; the breast and sides streaked with black and buff. Length six inches. See plate VIII facing page 186.

Breeds from Southern Illinois and Virginia northward to New Brunswick and Manitoba, and winters on the Atlantic coast from Virginia southward.

Seldom found in large flocks, frequents dry, open upland, roadsides and grassy fields. As one approaches it flits along with spread tail, showing the white outer feathers. The song is plaintive but otherwise resembles that of the Song Sparrow.

*Nest composed of rather coarse grass, lined with finer grasses, rootlets, and long hairs, placed on the ground. Eggs four to five; bluish white or pinkish white, speckled and spotted with rufous brown or umber; .83 by .61 inch.

The Biological Survey has collected 130 Vesper Sparrows in twelve States (mostly Massachusetts, New York, Iowa, and Kansas). The vegetable food forms 69%, and the animal food, 31% of the total, exclusive of March contents. In mid-summer the animal food constitutes 90%. The animal food consists of grasshoppers, weevils, dung beetles, cut-worms, and army worms. The vegetable food includes grain 11%, grass seed 16%, and weed seed 42%. Vesper Sparrows are less partial to grass seed than any other species of Sparrow, but select the usual run of weed seed,—ragweed, amaranth, lamb's quarter, wild sunflower, polygonums, smartweeds and purslane.

542a. *Passerculus sandwichensis savanna* (Wils.). The Savanna Sparrow.

The Savanna Sparrow is a sharply streaked bird, the streaks on the back being blackish; line above eye and edge of wing yellowish; *under parts white, heavily streaked with blackish and rufous*; breast feathers tipped with wedge-shaped marks. Length 5½ inches. See plate VIII facing page 186.

Breeds from Missouri and Northern New Jersey northward; winters from Southern Illinois and Virginia southward to Cuba and Mexico. In Pennsylvania it occurs as a spring and fall transient.

The Savanna Sparrow is a bird of the fields and hedgerows. Song a weak, insignificant, musical trill.

Nest composed of grasses and sometimes moss, lined with finer grass or hair, on the ground. Eggs four or five; bluish white, thickly marked, sometimes heavily washed, with reddish brown or cinnamon; .78 x .56 inch.

One hundred and nineteen Savanna Sparrows were collected by the Biological Survey in twelve States, during all months of the year excepting February and December. The examination of the stomachs shows that 46% of the food is animal (insects and their allies) and 54% is vegetable (practically all seeds). Savanna Sparrows are the greatest eaters of beetles among the Fringillidæ, and are marked consumers of grass seed.

The beetles include Carabidæ (ground beetles), Chrysomelidæ (leaf-beetles), weevils, Elateridæ (click-beetles), dung-beetles, rove-beetles, pill-beetles (Byrrhidæ), and some Lampyridæ (allies of the fireflies). Of all, the weevils are preferred. The Lepidoptera are represented mainly by cutworms. Other insect food consists of grasshoppers, ants, bugs, and flies. In August grasshoppers are eaten to such an extent that they form 34% of the food for the month.

Of the vegetable food grass seed constitutes 31%, grain 1% (mostly waste grain) and weed seed, 22%.

"It appears from this examination that the Savanna Sparrow is an exceedingly valuable bird. During the winter, when it is most granivorous, more than half of its food consists of weed seeds; and from May to August, when it is most insectivorous, beneficial insects form only 3 per cent. of the food, while insects of the injurious class amount to 45 per cent."

546. *Coturniculus savannarum australis* (Maynard). The Grasshopper Sparrow, Yellow-winged Sparrow.

The Grasshopper Sparrow is another species of the ground, and is correspondingly much streaked above, the feathers being edged with bay; *the breast is buffy, unstreaked*; wings and tail short; edge and bend of wing and line over eye yellow. There is a grayish mark on the outer feathers of the tail, all the feathers of which are pointed. Length 5 inches. See plate V facing page 172.

Found throughout Eastern North America and breeds from the Gulf States northward to Massachusetts and Minnesota. In Pennsylvania it is a fairly common summer resident.

The Grasshopper Sparrow is a bird of the fields, especially old dry ones, and is generally observed singly. When flushed it flies reluctantly, but rapidly, and for but a short distance. Its name is derived from the fact that its song suggests the rasping sound of the grasshopper: "pit-tuck, zee-e-e-e-e-e-e-e-e."

Nest composed of grasses, sometimes lined with hairs, on the ground. Eggs four to five; white, distinctly spotted and speckled with rufous; .73 x .54 inch.

The Biological Survey collected 170 Grasshopper Sparrows during February and from April to October, inclusive. Of the food 63% is animal, and 37% is vegetable.

Of the animal food, 57% is insects, 6% spiders, myriapods, snails and earth-worms. Twenty-three per cent. of the insect food consists of grasshoppers. Beetles and caterpillars are prominent in the food. Of the vegetable food, weed seeds form more than 25% and grain (waste) forms 2%. "It seems to be individually the most useful species of bird whose food habits have thus far been investigated."

547. *Ammodramus henslowi* (Aud.). Henslow's Sparrow.

Henslow's Sparrow has more yellow above than the Grasshopper Sparrow; *breast and sides marked with sharp, black streaks*. Tail graduated, outer feathers much shorter than middle. Head vinaceous; back, wing-coverts and middle tail-feathers rufous brown. Length 5 inches.

This bird breeds in Eastern North America locally from Missouri and Virginia northward to New Hampshire and Southern Ontario, and winters from about the southern limit of its breeding range to the Gulf of Mexico. In Pennsylvania it is a rare summer resident and very local, having been found nesting at East Bethlehem and in Perry County (Stone).

In general appearance and habits this bird resembles the Grasshopper Sparrow. The nest is composed of grasses, sometimes lined with hair and placed on the ground. Four or five eggs; grayish white, thickly and evenly speckled with pale rufous brown; .75 x .57 inch.

During the summer months four Henslow's Sparrows were collected by the Biological Survey. "The food consisted of beetles, cutworms, grasshoppers, bugs, and blackberries. The beetles consisted of ground-beetles, leaf-beetles, click-beetles and weevils. The bugs included soldier bugs and assassin bugs." This bird is of such local distribution and so rare that it is of little economic importance.

549. *Ammodramus caudacutus* (Gmel.). The Sharp-tailed Sparrow.

The Sharp-tailed Sparrow is ashy olive, back streaked with ashy buff and whitish, edge of the wings pale yellowish; no yellow spot about eye; a bright buff superciliary stripe. Length 6 inches.

Found along the Atlantic Coast, breeding from South Carolina to New Hampshire, and wintering from North Carolina to Florida. It is confined to the coast and hence is not a resident in Pennsylvania.

"* * * * A specimen in the National Museum collection was secured at Philadelphia." (Stone).

The Sharp-tailed Sparrow is confined strictly to the salt marshes of the coast, where it lives upon the ground and runs among the vegetation in search of food. Like other birds that live among rank vegetation it is shy and keeps pretty well out of sight. As it does not come into contact with cultivated crops, it is of very little economic importance.

552. *Chondestes grammacus* (Say). The Lark Sparrow or Lark Finch.

The Lark Sparrow is streaked above and ashy below; ear coverts chestnut; crown chestnut, black anteriorly, with whitish median and superciliary stripes; a black line through and below the eye; a conspicuous black streak on each side of the white throat; a black pectoral spot; middle tail feathers like back, the rest blackish, white tipped; a pale spot on primaries. Length $6\frac{1}{2}$ inches.

The Lark Sparrow is a bird of the interior of North America eastward to Illinois. It breeds from Texas to Manitoba and is accidental on the Atlantic Coast. "In Southwestern Pennsylvania this species may occur regularly in small numbers. Mr. S. N. Rhoads observed a single individual in Fayette County in June 1894." (Stone). "A very rare summer resident in Beaver County." (Todd).

The nest of grasses, lined with rootlets, finer grasses and long hairs, placed on the ground or in low trees or bushes. Eggs three to five; white or pinkish white, spotted, blotched, or scrawled with purplish or black, chiefly at the larger end; .78 x .60 inch.

The Biological Survey found from 167 Lark Sparrows that the animal food constitutes 27% and the vegetable food 73% of the total food of the Lark Sparrow. The animal food is all insects, of which grasshoppers form 14%, and in June 43%, of the total food. There are some weevils and other beetles and some caterpillars. About one-fourth of the insects are injurious.

The vegetable food is composed entirely of seeds,—one-half of which are grain and grass seed, while of the remaining half 40% is ragweed, polygonum, wild sunflower, purslane, wood sorrel, lamb's quarter and amaranth seeds. The first four are the more prominent.

554. *Zonotrichia leucophrys* (Forst.). The White-crowned Sparrow.

The White-crowned Sparrow is streaked above with but little chestnut; crown black, with a broad, white, median band; lores blackish; a white streak above the eye; under parts grayish white; throat like

breast but paler. Length seven inches. See plate IX facing page 196.

It breeds "from the higher mountain ranges of Western United States, Sierra Nevada, Rocky Mountains, and eastward, north of the Great Lakes to Labrador; in winter, over the whole of the United States, and south into Mexico" (Ridgway). In Pennsylvania the White-crowned Sparrow is a rather irregular spring and fall transient.

The White-crowned Sparrow is a bird of the trees and bushes. Its distinct head markings of black and clear white make it a conspicuous species. While with us bushes along roadsides seem to be favored, and from them its beautifully clear, soft song may be heard.

The nest is composed of grasses, is placed on the ground or in bushes. Eggs four to five; pale greenish blue, speckled and spotted with bay, especially at the larger end; .90 x .62 inch.

From two hundred and seventeen White-crowned Sparrows it was found that of the food 25% is animal and 75% is vegetable. The animal food consists of caterpillars, weevils and other beetles, ants, parasitic wasps, bugs, spiders, etc. The vegetable food includes weed seeds (51%), grain (15%), grass seed (4%), and fruit (5%).

558. *Zonotrichia albicollis* (Gmel.). The White-throated Sparrow.

The White-throated Sparrow is much streaked above with chestnut; crown black, with white median and superciliary stripes; *spot over eye* and edge of wing always *yellow*; *ashy below, whitening on the throat*. Length 7 inches. See plate VIII facing page 186.

It occurs throughout Eastern North America, breeding from Northern Michigan, and occasionally from Massachusetts, northward to Labrador, and wintering from Massachusetts to Florida. It is a common spring and fall transient in Pennsylvania.

This is one of our handsomest birds, its gray under parts, white throat and black and white head, being so marked as surely to attract attention. Like the White-crowned Sparrows, the White-throats are to be found in the bushes along roadsides but in greater numbers. They often occur in flocks of considerable size and are sweet singers.

The Biological Survey collected 217 White-throats during every month of the year, except June, and mostly from New York and Pennsylvania. Nineteen per cent. of the food is animal and 81% is vegetable. The animal food is composed of Hymenoptera (allies of the wasps, bees, and ants), 6%; beetles, 5%; bugs and flies, 3%; Lepidoptera (moths and butterflies), 3%; spiders, millipeds, and snails, 2%. These birds seem partial to ants. The vegetable food includes grain, 3%; weed seed, 50%, and the remainder wild fruit.

559. *Spizella monticola* (Gmel.). The Tree Sparrow or Winter Chippy.

The Tree Sparrow is streaked above; crown chestnut; bill black above and pale below; neck, line over eye, and under parts ashy gray; a dark pectoral blotch; white wing bars distinct; an *indistinct black spot on the breast*. Length, 6 1-3 inches. See plate IX facing page 196.

Occurs in Eastern North America and breeds in Labrador and the region about Hudson Bay. In winter it moves south through the Eastern United States and west to the edge of the Great Plains. In Pennsylvania the Tree Sparrow is a common winter resident.

So commonly does the Tree Sparrow occur in this State, and so brave is it in facing the blasts of winter, that at that time of the year it is frequently the only bird met with in the fields. There it is more commonly seen flitting among bushes or about trees that are growing along fences. It may be readily recognized by its *chestnut crown, white wing bars, and black spot on the breast*.

Nest of grasses, rootlets, and hair, on or near the ground. Eggs four to five; pale green or greenish blue, spotted with reddish brown; .75 x .60 inch.

Of five hundred and seventeen Tree Sparrows seeds constitute 98% of the food. Prominent among the seeds are those of grass—mainly pigeon grass and panicums—which form one-half of the food. Of the weed seeds, two-thirds are those of ragweed, amaranth, lamb's quarter, and polygonums. The animal food forms but two per cent. and includes weevils and other beetles, wasp-like insects, ants, caterpillars, bugs, grasshoppers, and spiders.

560. *Spizella passerina* (Bechstein). The Chipping Sparrow or Chippie.

The Chipping Sparrow has a black forehead with a short grayish line in the middle; *top of head rufous*; grayish line over the eye, black line behind it; back of neck grayish; back streaked; rump slaty gray; wing bars inconspicuous; under parts grayish white; throat and belly whiter. Length about 5½ inches. See plate III facing page 166.

Occurs throughout Eastern North America, breeding from the Gulf States to Newfoundland and the Great Slave Lake, and wintering in the Gulf States and Mexico. In Pennsylvania it is common everywhere in spring, summer, and fall, arriving about the first of April, and departing about the first of November.

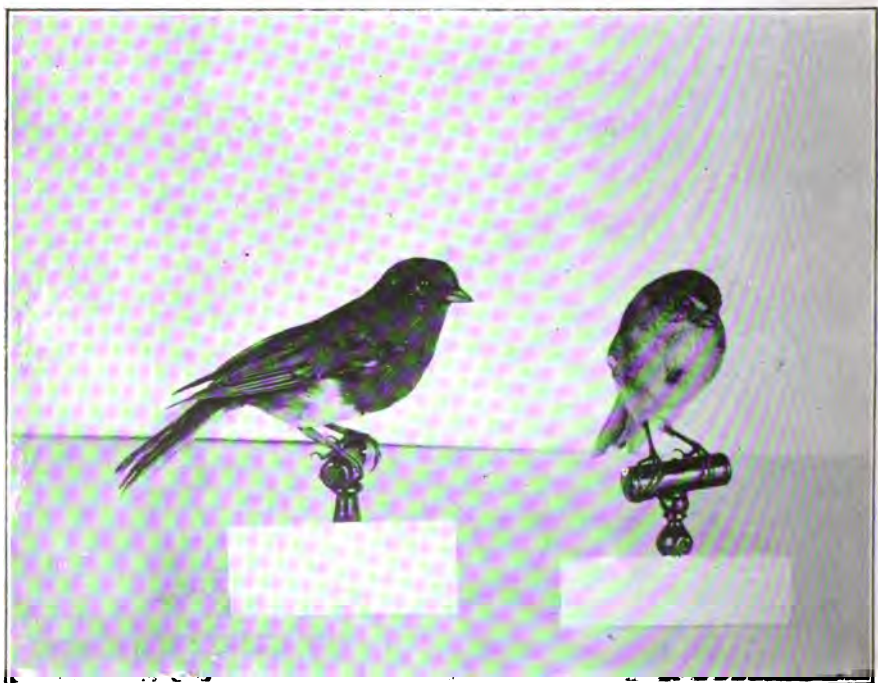
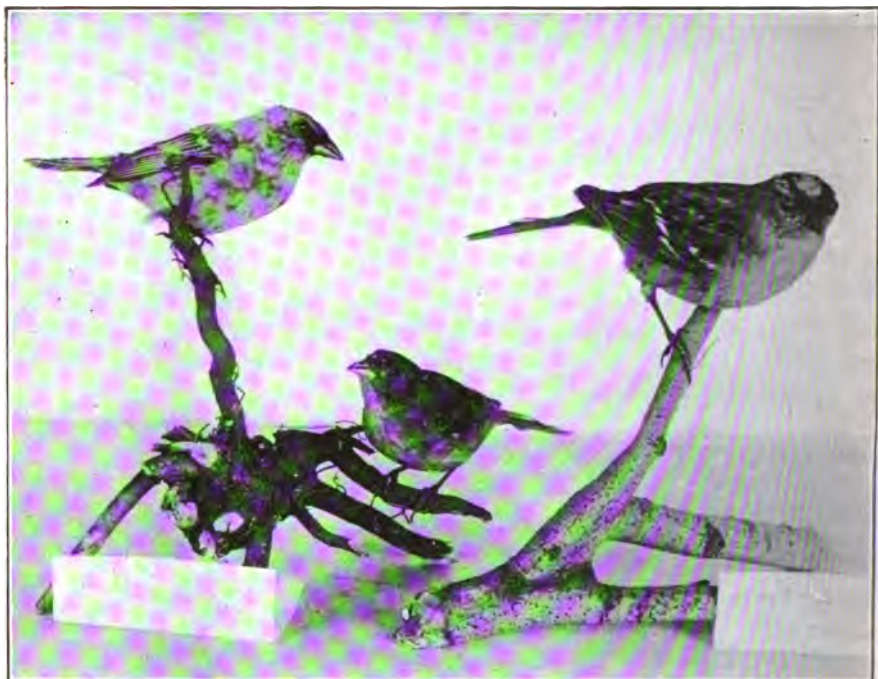


Plate IX. The Indigo Bunting (two birds at upper left-hand) and the White-crowned Sparrow (upper right-hand). The Slate-colored Junco (lower left-hand) and the Tree Sparrow (lower right-hand).

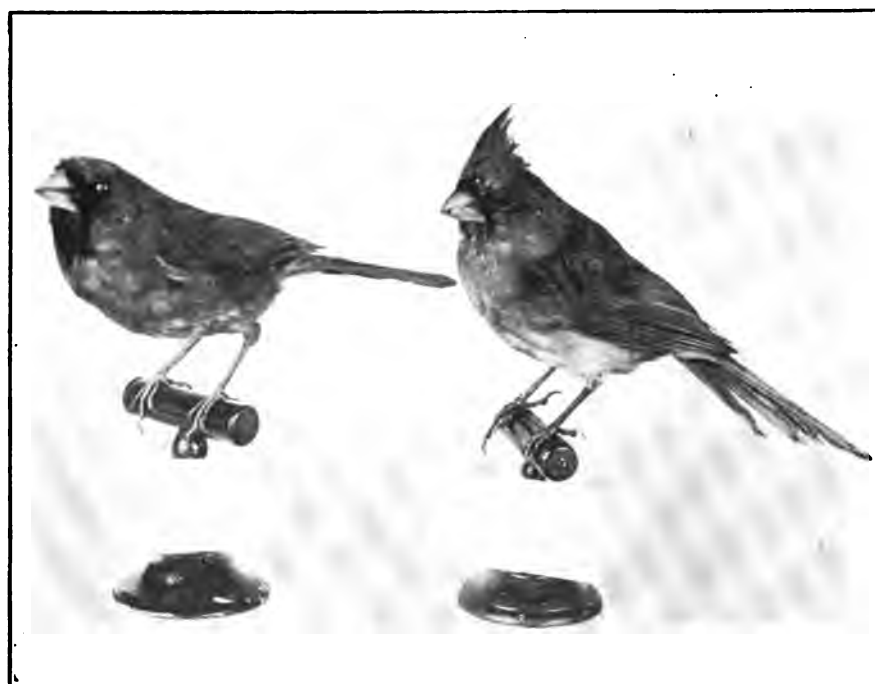
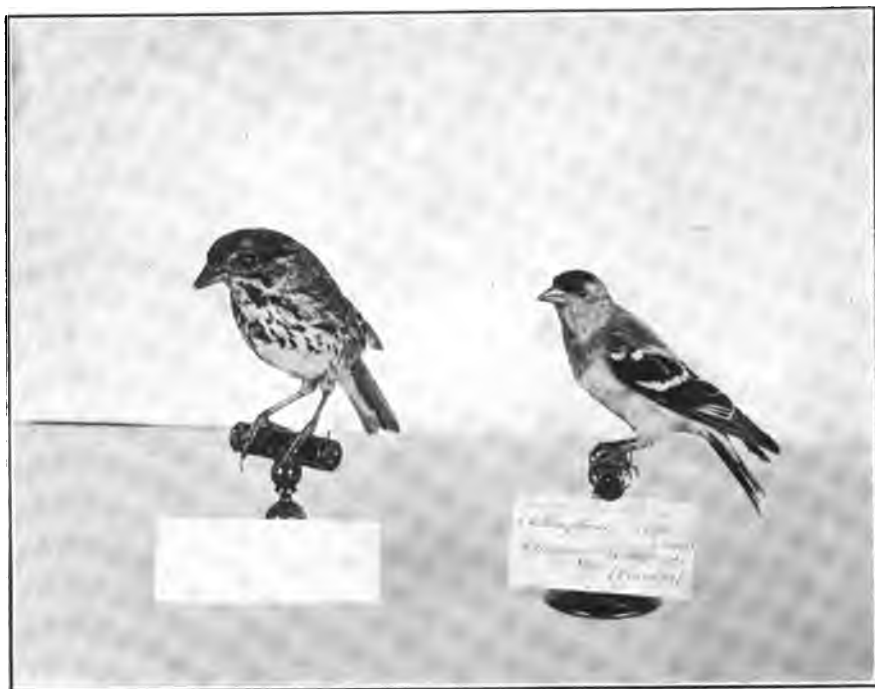


Plate X. The Song Sparrow (upper left-hand) and the American Goldfinch (upper right-hand). The male Cardinal Grosbeak (lower left-hand) and the female (lower right-hand).

The Chipping Sparrow is one of our commonest summer residents. It is a most confiding bird, loving to live and nest near the home of man. Its song, although uttered with sincerity, is a monotonous "*chippy-chippy-chippy-chippy*."

The nest is built in trees or bushes from five to twenty feet from the ground, of grasses, fine twigs or rootlets, thickly lined with long hairs. Eggs four to five; blue or greenish blue, with cinnamon brown or blackish markings, chiefly at the larger end; average .72 x .51 inch.

Two hundred and fifty Chipping Sparrows were collected by the Biological Survey. The food consists of animal matter 38% and vegetable matter 62%. The animal food includes weevils, 6%; leaf-beetles, 2%; other beetles including predaceous ground-beetles, dung-beetles, click-beetles and May-beetles, 3%; caterpillars, 9%; grass-hoppers, 10%; miscellaneous leaf-hoppers, true bugs, ants, spiders, parasitic wasps, 8%. Only one per cent. of the insects are useful species, while over 25% are injurious.

The vegetable food includes grain, 4% (principally oats); grass seed, 48% (crab-grass, pigeon grass, timothy, orchard grass and others); other seed, 10% (clover, ragweed, amaranth, wood sorrel, lamb's quarter, purslane, knot weed, chickweed and black bindweed).

563. *Spizella pusilla* (Wils.). The Field Sparrow.

The Field Sparrow has the *top of the head rufous*; a gray line over the eye; back of neck slightly gray; back rufous but finely *streaked with black* and narrowly edged with brownish ashy; rump brownish ashy; middle and greater wing coverts tipped with white; under parts white, tinged with ochraceous buff on the breast and sides; beak reddish brown. Length, about 5½ inches.

It occurs in Eastern North America, breeding from Southern Illinois and South Carolina to Quebec and Manitoba, and wintering from Illinois and Virginia southward—an abundant summer resident in Pennsylvania.

During its sojourn in Pennsylvania the Field Sparrow is, as its name implies, a bird of the fields, not open fields, but those supplied with bushes or other shrubby growth. Unassuming birds they are, and their clear, appealing song is suggestive of their lovable nature. The song begins with clearly whistled "*cher-wee-cher-wee, cher-wee*" and ends in a most pleasant trill.

The nest is composed of rather coarse grasses, weed stalks, rootlets, etc., lined with fine grasses and long hairs and placed on the ground or in a low bush. The full compliment of eggs numbers three

to five; white or bluish white, with numerous rufous markings, chiefly about the larger end; average .70 x .52 inch.

The Biological Survey collected 175 Field Sparrows in fifteen States. The food is animal matter 41%, and vegetable matter 59%. The former includes weevils, leaf beetles, ground beetles, tiger beetles, click beetles and May beetles; caterpillars, grasshoppers, leaf hoppers, true bugs, sawflies, ants, flies, parasitic wasps, and spiders. The vegetable food includes grass seed, weed seeds and grain. Prominent among the grass seeds are those of crab grass and other panicums, pigeon grass, brown sedge, poverty grass, and sheathed rush grass. Important weed seeds are those of chick weed, lamb's quarter, grom-well, amaranth, purslane, spurge, wood sorrel, and knotweed. A little timothy seed is eaten. Oats amount to 4%, but in August they are picked up from stubble to the extent of 25%.

567. *Junco hyemalis* (Linn.). The Junco or Slate-colored Snowbird.

The Junco (commonly called "Snowbird") is a plainly but beautifully clad bird. The upper parts, throat and breast are grayish slate color; the first more or less washed with grayish brown; belly white, sides grayish; no wing bars; tail fuscous, the two outer feathers and part of the third white; bill flesh color. Length, 6½ inches. See plate IX facing page 196.

The Junco breeds from Northern Minnesota and Northern New York northward; also southward along the crests of the Alleghanies to Virginia; winters southward to the Gulf States. It is a common winter resident in Pennsylvania from October first to May first and is found all the year in some of the higher parts of this State.

Few of our winter birds are better known than the Junco. It is inconspicuous because of its prevailing gray color, but is at the same time conspicuous because it visits us in large numbers when the snow is on the ground. They are confiding, active birds, well prepared to brave the storms of winter by their thick coats of feathers and their cheerful disposition.

The nest is made of grasses, moss and rootlets, lined with fine grasses and long hairs, placed on or near the ground. Eggs four to five; white or bluish white, finely and evenly speckled or spotted, sometimes heavily blotched, at the larger end with rufous brown; average .76 x .58 inch.

For the whole year the food is divisible into 22% animal matter and 78% vegetable matter. The summer diet, however, includes 49% animal food and 51% vegetable food. Of greatest interest to Pennsylvania farmers, however, is the winter food, 9% of which is animal

matter and 91% vegetable matter. The former is of the usual insect character. The latter includes timothy, brown sedge, sheathed rush grass, pigeon grass, crab grass and other panicums, paspalum, ragweed and polygonum, amaranth, lamb's quarter, chickweed, purslane, vetch, gromwell, wood sorrel, sedge, sheep sorrel, wild sunflower and Russian thistle.

581. *Melospiza melodia* (Wilson). The Song Sparrow.

The Song Sparrow is distinctly streaked above, on the sides, and on the breast. An obscure ashy median stripe marks the crown. The under surface of the body is white, but the breast shows wedgeshaped streaks of black and rufous-brown which tend to form a *large blotch on the center of the breast*, while the sides are washed with brownish and streaked with black and rufous-brown. Length, 6½ inches. See plate X facing page 196.

This species is found throughout the United States. In Eastern North America it breeds from Northern Illinois and Virginia north to Quebec and Manitoba, and winters from Southern Illinois and Massachusetts to the Gulf States. In Pennsylvania the Song Sparrow is an abundant summer resident and rather common permanent resident. Our citizens do not seem to know this generally, as it is common to hear some one say in the spring, "The song sparrows are back; I heard the first one yesterday."

The Song Sparrow appeals to everyone that knows it. It hops about with a chip and with tail held quite erect. It is a bird of the ground and is especially fond of being near water courses. When it sings it generally mounts to a conspicuous perch, such as a bush, or tall growing herb and there with drooping tail and head held high it pours forth its song. This may be heard at almost any time of the year, rarely during the winter, but singing really begins in February. To Dr. Henry Van Dyke the Song Sparrow sings: "*sweet, sweet, sweet, very merry cheer.*" The first three words suggest the distinct notes uttered in measured time while the last three suggest the trill. The Song Sparrow portrays a most admirable disposition and deserves a position second to none among our singers.

Nest of coarse grasses, rootlets, dead leaves, strips of bark, etc., lined with finer grasses and sometimes long hairs, placed on the ground, sometimes in bushes. Eggs four to five; white or bluish white with numerous rufous-brown markings, which sometimes nearly conceal the ground color; average .76 x .60 inch.

The Biological Survey collected 401 Song Sparrows in twenty-six States and in British Columbia and during every month of the year.

The food includes 34% of animal matter and 66% of vegetable matter. The animal matter is composed of flies, bugs, Hymenoptera (ants, bees, wasps, etc.), Lepidoptera (moths and butterflies), Orthoptera (grasshoppers, crickets, etc.), beetles and miscellaneous insects. But 2% of these insects are useful, while 18% are injurious.

The vegetable matter is composed of 5% grain, 16% seeds of polygonums and related plants, 3% ragweed seed, 24% grass seed, 18% miscellaneous seed (wild sunflower, amaranth, lamb's quarter, clovers, gromwell, rib-grass, wild solanum, purslane, spurge, wood sorrel, dandelion, chickweed, dock and sheep sorrel), and 8% blackberries, strawberries, raspberries, blueberries, mulberries, and wild black cherries.

583. *Melospiza lincolni* (Aud.). Lincoln's Sparrow.

Lincoln's Sparrow is *everywhere* above and below thickly and sharply streaked with black, gray and buffy; breast with a broad band of pale buffy or yellowish brown, sides washed with buffy. Length 5½ inches.

Lincoln's Sparrow is found in Eastern North America, breeding from Northern Illinois and Northern New York northward, and wintering from Southern Illinois to Mexico. East of the Alleghany Mountains it is rare in Pennsylvania. "Rare and irregular during the migrations" (Stone). "Chestnut Hill, Philadelphia, two records 1871 and 1880, and Haverford 1884" (Stone).

This bird is closely related to the Song Sparrow and resembles it slightly in habits, as it is a ground-loving bird that likes to move in mouse-like fashion among the herbage. Aside from this slight resemblance, the birds are very different. The Song Sparrow is well known to be a confiding bird, but Lincoln's Sparrow is distinctly shy and retiring.

Thirty-one Lincoln's Sparrows were collected by the Biological Survey mainly in Massachusetts and New York. The food was found to be composed of 42% animal matter and 58% vegetable matter. Of the animal food 40% is insects and 2% spiders and millipeds. Useful insects, largely. Hymenoptera, with some predaceous beetles form 4% of the food, and injurious insects, 12%. Neutral insects, including beetles, ants, flies and some bugs, amount to a fourth of the food. More ants (principally Myrmicidæ) and fewer grasshoppers are destroyed than by the Song Sparrow."

584. *Melospiza georgiana* (Lath.). The Swamp Sparrow.

The Swamp Sparrow has a *bright dark chestnut crown, streaked with black*; wings strongly tinged with chestnut, back sharply streaked; an ashy collar and superciliary line; breast and under parts ashy, *with few streaks or none*; tail shorter than in the Song Sparrow, its quills edged with chestnut. Length, $5\frac{1}{2}$ inches.

This Sparrow belongs to Eastern North America, where it breeds from Northern Illinois and Pennsylvania northward to Labrador, and winters from Southern Illinois and Massachusetts to the Gulf of Mexico. In Pennsylvania the Swamp Sparrow is found as a permanent resident, except that in the southern part of the State it is known to occur only during the breeding season. Within our limits the Swamp Sparrow merits its name, as it is found about wet lands. It is closely related to the Song Sparrow which it resembles slightly but, like Lincoln's Sparrow, is shy and timid.

Nest generally similar to that of the Song Sparrow, placed on the ground. Eggs four to five; similar in color to those of the Song Sparrow but the markings are generally more confluent; average .76 x .57 inch.

The Biological Survey collected 72 Swamp Sparrows during the months of February, and April to November, inclusive, and principally in Massachusetts, Connecticut, New York and Pennsylvania. Of the food, 47% is animal, and 53% vegetable matter. Forty-five per cent. of the animal food consists of insects, and these include 2% grasshoppers, 9% caterpillars, 11% leaf beetles and weevils, 17% bugs, ants, flies, and smaller dung-beetles. One-seventh of the stomachs contained ants.

The vegetable matter is represented by such seeds as are to be found in moist situations. More polygonum (smartweed) seeds are eaten than by other birds. The seeds are largely represented by sedges, aquatic panicums, and giant ragweed (*Ambrosia trifolia*).

585. *Passerella iliaca* (Merr.). The Fox Sparrow.

The Fox Sparrow is ashy above, overlaid and much streaked with rusty red, which becomes bright bay on the rump, tail and wings; white below, with *large arrow-shaped brown and black spots and streaks numerous on the breast*; feet stout with long claws. Length, 7 inches. See plate VII facing page 186.

This large Sparrow breeds from the Magdalen Islands and Manitoba to Alaska, and winters from Virginia southward. In Pennsylvania it is a fairly common spring and fall transient.

The Fox Sparrow is not to be confused with any other bird in our limits, as it is our largest Sparrow, and is very distinctly marked with its rusty red back and large red spots and streaks on the breast. While with us it is generally a bird of thickets or hedgerows, and is seldom seen in open stretches of country. The song is exceedingly rich, clear, and powerful, and is generally heard in spring at sundown.

In food they average 14% animal matter and 86% vegetable matter. The animal food is of little interest except that in April 20% of all the food is millipeds (*Julus* group), and 10% is ground beetles (Carabidæ).

Less than 1% of the vegetable food is grass seed. The Fox Sparrow consumes less grain and more fruit, ragweed, and polygonums than other Sparrows. Twenty-eight per cent. of the food is composed of the seeds of berries and fruit. One-half of the plant food is represented by the seeds of ragweed and polygonums, and over one-fourth by fruit.

587. *Pipilo erythrophthalmus* (L.). The Chewink or Towhee, Marsh Robin, Joree, Ground Robin, Woods Robin.

The Chewink is distinctly marked with black, this replaced by white on the belly, and by chestnut on the sides; *outer tail feathers, primaries and inner secondaries white*. In the female the black is replaced by clear brown. Length, $8\frac{1}{2}$ inches.

This bird belongs to Eastern North America, where it breeds from the lower Mississippi Valley and Georgia northward to Maine, Ontario and Manitoba, and winters from Virginia to Florida. During the breeding season the Towhee is common everywhere in Pennsylvania.

The names Chewink, Towhee and Joree are applied in imitation of its call of alarm or of inquisition. It is a restless, active bird, flitting through bushes or searching for food on the ground, often startling a person by the sound it produces in displacing leaves as it searches among them. Its song consists of two tones followed by a tremulous whistle, and is represented by Ernest Thompson "*chuck-burr, hill-a-will-a-will-a.*"

Its nest is placed on or near the ground and is composed externally of dead leaves and strips of bark, lined with fine grasses. Eggs four to five; white, finely and evenly speckled with shades of rufous, sometimes blotched at the larger end; .96 x .71 inch.

"The food is secured mainly from the ground, from shrubbery, and as high on the tree trunks as the bird can reach or jump. In early



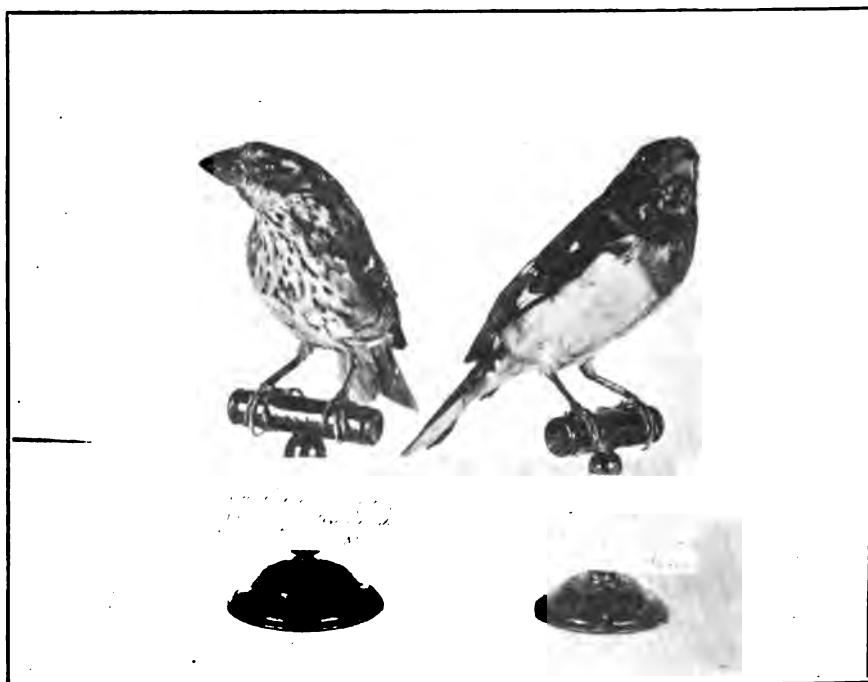


Plate XI. The Rose-Breasted Grosbeak (young male at left and adult male at right).

spring it unearths many dormant insects. Many beetle larvæ are thus found, among them the white grubs of the May beetle, many ground beetles and ants, many of the smaller nocturnal moths, and many hairy caterpillars. When near gardens or cultivated fields, it is said to feed on potato beetles and cabbage worms, grasshoppers, cockroaches, flies and earthworms. The vegetable food is composed largely of fruit and weed seeds. Wild berries are eaten much in summer. The only cultivated fruit is a few gooseberries gathered from the ground." (Folsom).

593. *Cardinalis cardinalis* (Linn.). The Cardinal or Red-bird.

The Cardinal, as its name implies, is clear red; ashy on the back; chin and forehead black; crest conspicuous. The female is ashy brown, more or less washed with red. Length, $8\frac{1}{2}$ inches. See plate X facing page 196.

The home of the Cardinal is in the Eastern United States, west to the Great Plains. It breeds from Florida to Iowa and Southern New York, and is resident throughout its range.

To many persons the Cardinal was once best known as a cage bird, and as such it is generally called the Red-bird. Real lovers of Nature, however, decidedly prefer to hear its song in the woods. A peculiar feature of the Cardinal is that the female is also a singer, the song being softer than that of the male, and accordingly very pleasing.

The nest is composed of twigs, rootlets, and strips of bark, lined with grasses and rootlets, and is placed in bushes. Eggs usually three to four; white or bluish white, speckled or spotted with grayish brown, cinnamon or umber; $1.00 \times .70$ inch.

The Biological Survey collected 498 Cardinals during every month of the year, and in twenty States, the District of Columbia, and Ontario. The greatest number of birds, however, were collected in Texas during May. The food is divisible into animal (28.99%) and vegetable (71.01%). Of the animal food, 26.25% is insects, the remaining 2.74% including millipeds, centipeds, spiders, bivalves and univalves. The insects are represented by wasps, bugs, butterflies, caterpillars, grasshoppers and beetles.

The vegetable food includes 8.73% grain (mostly waste), 24.17% wild fruit (only seeds usually eaten),—wild grape, blackberries, raspberries, mulberries, huckleberries and cherries—36.38% weed and other seed (smartweed, bindweed, grasses and sedges), and 1.73% miscellaneous matter.

"The Cardinal has been accused of pilfering certain grains, notably corn, to an injurious extent, which charge the evidence from

stomach examination neither proves nor disproves. But in view of the fact that only 8.73% of the total food is grain, and that more than half of that amount is waste, the loss is greatly overlooked by the destruction of weed seeds named above, which compose more than half of the vegetable food. Some of the weeds consumed are especially destructive to grain crops.

"In securing the insect food the Cardinal ignores us in one case and helps us in fifteen. In other words, considering the animal food above, only one Cardinal does harm, to fifteen which do good. The presence of this single harmful bird among so many beneficial ones no more justifies us in classifying the species as injurious than would a like proportion of disabled men justify the condemnation of a whole regiment." (W. L. McAtee).

595. *Habia ludoviciana* (Linn.). The Rose-breasted Grosbeak.

The male Rose-breasted Grosbeak has the head, neck, and upper parts mostly black, with white on the rump, wings, and tail; *breast* and under wing coverts of an *exquisite rose red*; bill very stout and pale. The female is olive brown, much streaked, with the under wing coverts saffron yellow, head with whitish stripes. Length, 8½ inches. See plate XI facing page 204.

This species occurs in North America from the Atlantic seaboard to Colorado and breeds from Eastern Kansas and the higher altitudes of Virginia and North Carolina northward to Maine and Manitoba. It winters in Cuba, Central and South America. In the western portion of Pennsylvania the Rose-breast occurs as a common summer resident, but in the eastern portion it does not often occur south of Monroe and Schuylkill Counties.

During the migration the Rose-breasted Grosbeak is commonly observed in trees standing well apart, but during the breeding season it prefers second growth or woodland areas with much undergrowth. Its black, white, and red coloration render it readily observed. Its song resembles that of the Robin in the tones and their rythm, but is considered by many to be superior in quality to that of the Robin.

The nest is composed of fine twigs, weed stalks, and rootlets, and is placed in bushes or trees from 5 to 20 feet above the ground. Eggs four to five; pale blue with numerous olive-brown or rufous brown markings; .90 x .69 inch.

"The food is secured largely on trees. In summer the food consists largely of insects, many of which are the greatest pests of woodland, orchard and garden. Hairless caterpillars are continually sought. Leaf rollers are extracted with skill. Gypsy and tussock moths are

fed on to some extent. Beetles and their larvæ, particularly leaf-eating and boring species, are sought. On the ground are found large caterpillars, such as army worms, and grasshoppers, and locusts. The vegetable food includes weed seeds, wild cherries, and seeds of alder and birch." (Folsom).

597. *Guiraca cærulea* (Linn.). The Blue Grosbeak.

The male Blue Grosbeak is rich blue; the feathers about the bill and the wings and tail black; wing bars chestnut. The female is yellowish brown, with whitish wing bars. Length, 7 inches.

This Grosbeak breeds from about the 38th degree of latitude southward into Mexico, and winters south of the United States. In Pennsylvania it is a very rare straggler, being recorded in Cumberland and Lancaster counties (formerly bred), Delaware and Philadelphia counties. (Stone).

"Unless seen under the most favorable circumstances the adult male does not appear to be blue, but an ill-defined, dusky color, and may easily be mistaken for a Cow Blackbird (*Molothrus ater*), unless most carefully watched; besides, they usually sit motionless in a watchful attitude, for a considerable length of time, and thus easily escape observation." (Chapman).

"Present data show that the food of the Blue Grosbeak is 67.6% animal and 32.4% vegetable. Grain constitutes 14.25% of the diet but, on account of the scattered distribution of the birds, no appreciable damage is done during most of the summer. Later, however, when they forage in flocks, they are said to do considerable injury. But as noted above the birds consume twice as much animal as vegetable matter, and even if all of the latter had been grain, instead of less than half as is actually the case, it would have been paid for many times over.

Among the important insect pests eaten by the Blue Grosbeak are grasshoppers, weevils, the purslane sphinx, and cutworms. The species deserves protection for its destruction of grasshoppers alone, and when its food habits are considered in their entirety the showing unquestionably is greatly in favor of the bird." (Bulletin 62, U. S. Biological Survey).

598. *Passerina cyanea* (Linn.). The Indigo Bunting or Indigo-bird.

The Indigo Bunting is *rich indigo blue*, deeper on the head, brighter on the back; lores blackish; wings and tail black, margined with blue. The female is plain, warm brown obscurely streaked and is

separated from other small Sparrows by a dusky line along the middle of the lower mandible, slight tinge of blue on the outer web of the wing and tail-feathers, and unstreaked back. Length $5\frac{1}{4}$ inches. See plate IX facing page 196.

The Indigo Bunting breeds as far north as Minnesota and Nova Scotia, and winters in Central America. In Pennsylvania it occurs as a common summer resident from May to October.

It is generally found in clumps of bushes along fences or in clearings and old pastures. The female is a shy bird and because of this fact and its dull colorings is seldom observed, while the bright colored male is frequently seen.

The nest is composed of grasses, bits of dead leaves, and strips of bark, lined with fine grasses, rootlets, and long hairs, generally in the crotch of a bush near the ground. Eggs three to four; pale bluish white; $.73 \times .57$ inch.

"It feeds more on the caterpillars that infest trees and bushes than do most Sparrows, and takes many such larvæ to its young. It is fond of grasshoppers and takes some insects from the garden. It eats the birch plant-louse with avidity. A few flies, mosquitoes, or gnats are taken; cankerworms and other measuring worms, the larvæ of several species of butterflies, and the imagoes of nocturnal and Tineid moths, while small beetles of different species constitute a portion of its insect food. The larger part of its food consists of seeds, many of which are those of weeds. During its short stay with us it is one of the few useful species seen much about the garden, and is of some service in the orchard." (Folsom).

604. *Spiza americana* (Gmel.). The Dickcissel or Black-throated Bunting.

The male Dickcissel is grayish and streaked above; wing coverts chestnut; line over eye, maxillary stripe, edge of wing, breast and part of belly yellow; throat patch black; otherwise white below. The female has but little chestnut, and the black is reduced to dark streaks. Length, $6\frac{1}{4}$ inches.

The Dickcissel occurs mostly in the Mississippi Valley, breeds from Texas to Minnesota and winters in Central America and South America. East of the Alleghanies this bird breeds only rarely and locally now. In Pennsylvania it is "a very rare straggler. Twenty years ago (1874) this was a common species in certain parts of New Jersey and Eastern Pennsylvania, though always of local distribution. It formerly bred near Frankford, Pa. * * * * as late as 1879" (Stone). It is a bird of pastures and grass grown fields.

The Biological Survey showed that 70% of the food is animal and 30% is vegetable material. Of the animal food, 68% is composed of insects. These are represented by flies, bugs, Lepidoptera (moths and butterflies), beetles, grasshoppers and crickets and Hymenoptera (ants, bees, wasps, etc.). The remaining 2% is composed of invertebrates such as spiders and snails.

The vegetable food is composed largely of the seeds of millet, pigeon-grass, closely related species, and some panicums. The large percentage of millet is accounted for by the fact that so many of the birds were collected in Kansas, a millet growing State. Some grain, other than millet, is also eaten.

GLOSSARY.*

- Acute*, sharp-pointed.
Arboreal, inhabiting trees.
Beak, the bill of birds.
Bend of wing, the angle where the wing is folded.
Bristle, a stiff hair or hair-like feather.
Crest, a group of lengthened feathers about the head.
Crissum, the under tail-coverts.
Culmen, the middle line or ridge of the upper mandible.
Decurved, curved downward.
Erectile, capable of being erected.
Femur, the leg-bone next the body.
Fuscous, grayish brown.
Gape, the opening of the mouth.
Lore, the area between the eye and the bill.
Mandible, one of the two parts of the bill.
Nape, upper part of the neck.
Obsolete, scarcely evident.
Olivaceous, olive green.
Primary, one of the long, stiff quill-feathers attached to the hand-bones of a bird.
Scutellum, one of the plates on the tarsus of a bird.
Secondary, one of the quill-feathers of the wing, arising from the forearm.
Superciliary, immediately above the eye.
Tail coverts, the small feathers overlapping the tail-feathers.
Tarsus, the bone between the tibia and the toes.
Umber, a dark brown.
Vinaceous, deep cream buff.
Wing-coverts, the small wing-feathers covering the shoulder.

*See Plate I for a graphic explanation of the terms used in describing the topography of a bird.

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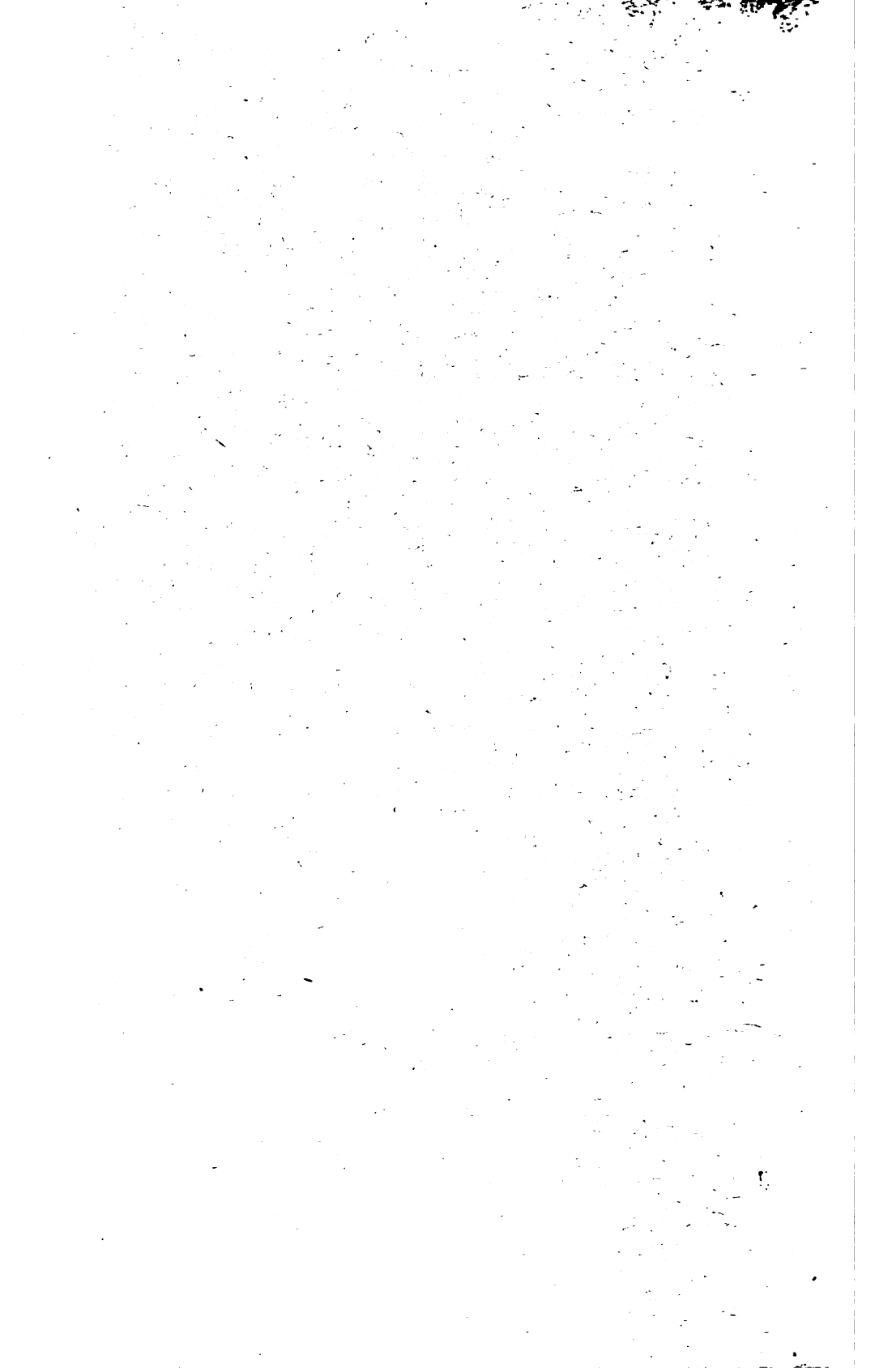
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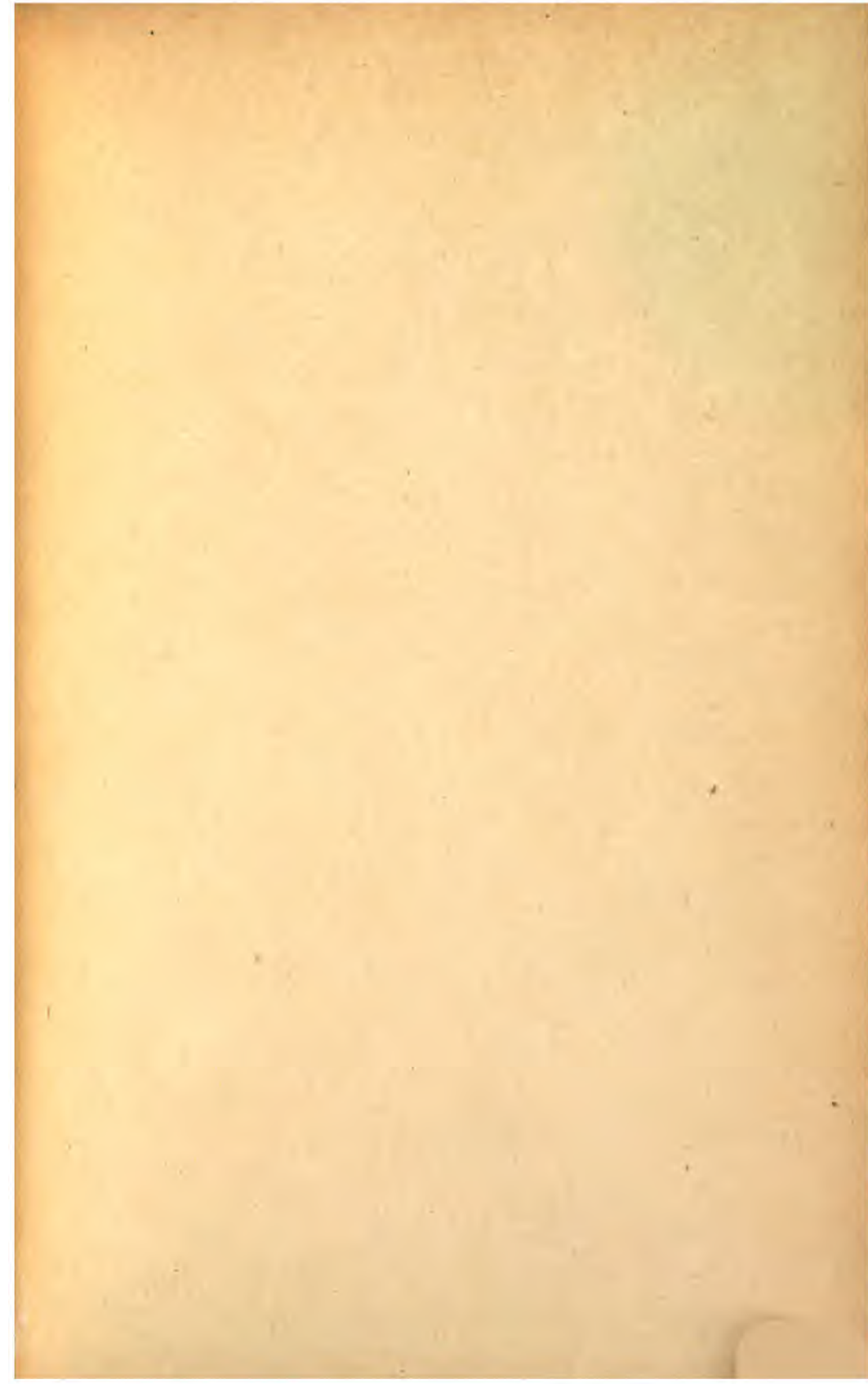
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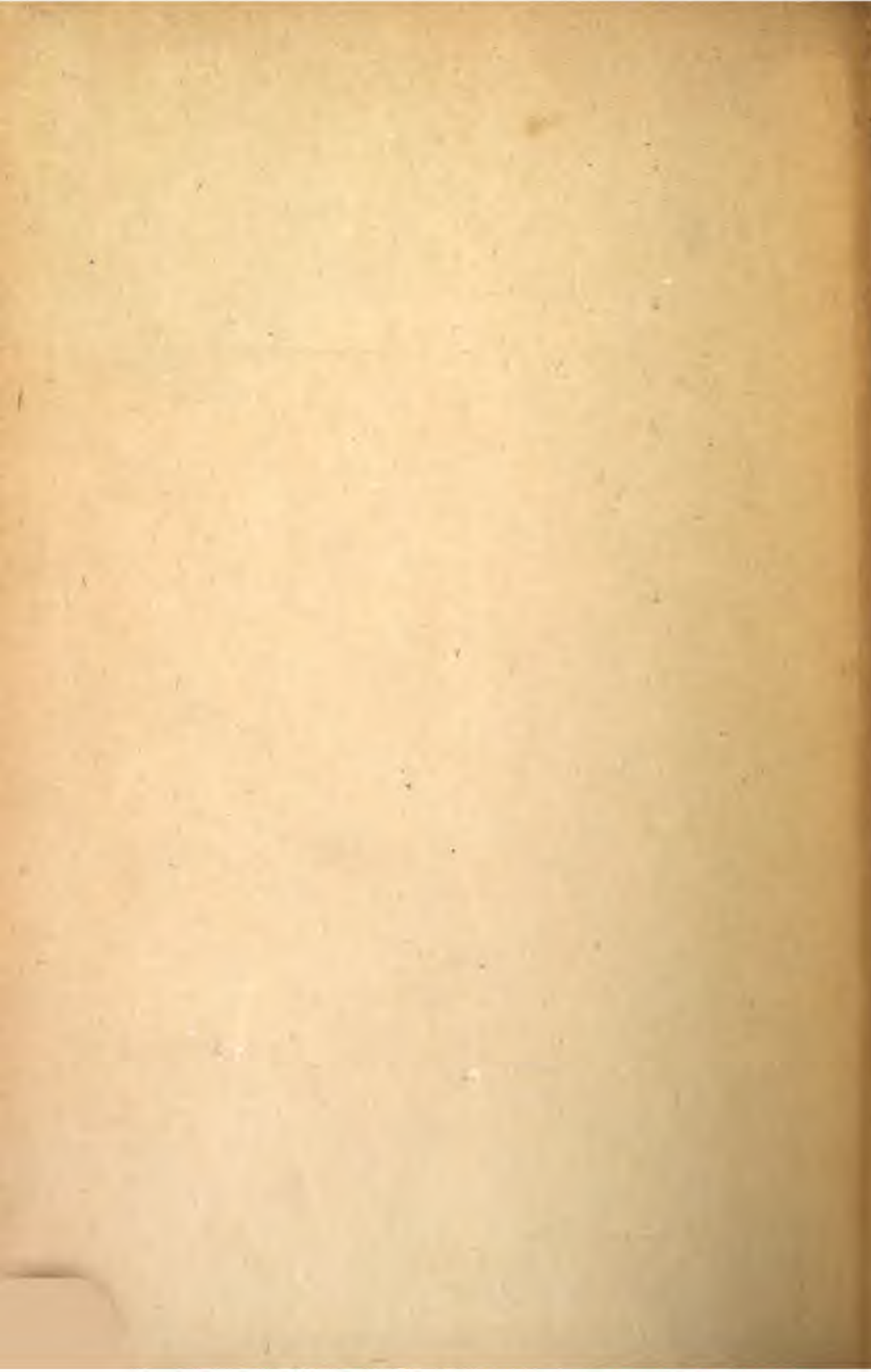
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